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LOWLY WATER ANIMALS

WITH ILLUSTRATIONS.

BY

N. D'ANVERS,

Author of "The Earth and its Early Explorers;" "Vegetable Life and its Lowest Forms;" etc. etc.

"The great thing is to get your foot on the first rung of the ladder."

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PART I.

LOWEST FORMS OF WATER ANIMALS.

CONTENTS.

ILLUSTRATIONS.

LOWEST FORMS OF WATER ANIMALS.

LESSON I.[1]

WHAT AN ANIMAL IS.

IN this little book we will read together something about the lowest forms of water animals. We must first of all try and understand what an animal is.

An animal is a living, breathing creature, which can move about from place to place of its own free will. In another little book on "Flowerless Plants," you will read of tiny plants which can also move about of their own accord, and, if you remember what I tell you now, when you read that book, I dare say you will think there is not, after all, much difference between some tiny plants and some tiny animals. You will be quite right if you *do* think so. Learned men have been trying, for many hundreds of years, to find out exactly what is the difference

[1] Every child using this book should be provided with a dictionary, and look for every word he or she does not understand.

between the lowest plants and animals, and they have not yet succeeded. They can only say that most plants are unable to move, of themselves, from one place to another, and that most animals can move about freely. I give you here pictures of two of the tiny water plants which can move about freely. When you have looked at them carefully, turn to the different

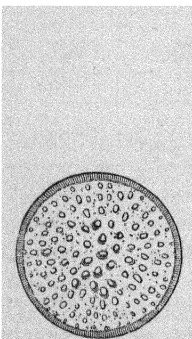


Fig 1.—Diatom, greatly magnified.

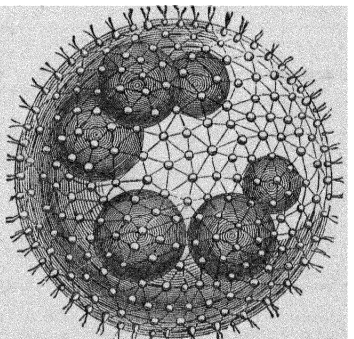


Fig. 2.—Volvox, greatly magnified.

pictures of tiny animals in later lessons. This will help you to see in what they are alike and in what they are different.

It is quite easy for you all to understand what it is to be able to move about freely, and I dare say you will think you also know exactly what it is to live and breathe. You know the difference between a living body and a dead one. A living body is one that can breathe,

and a dead body is one that cannot breathe. If you look at a living body and a dead one of the same kind, side by side, you will see that the dead one has the same parts as the living one. It is the breath alone which is wanting, and which none but God can give. Now there is a hard word used in speaking of bodies to which God has given breath, which I have already explained in a little book on "Vegetable Life." That word is ORGANIC, and it means made up of organs. Organ means an instrument or tool, and the organs of bodies to which God has given life are the instruments or tools by means of which the life in the bodies acts. Your tongues are your organs of taste; your eyes are your organs of sight; and so on. Bodies which have never had any breath, and therefore do not live, are called inorganic. Such bodies have no actions to perform, they can do nothing of themselves, and they need no organs or tools. A stone is an inorganic body. It cannot breathe or move—it has no life.

There is one other great difference between organic and inorganic bodies. I have already explained it in teaching you about "Vegetable Life." Organic bodies have the power of growing from within, and inorganic bodies can only be added to from without. As soon as an organic body, such as a plant, a bird, or a baby is born into the world, it begins to grow from within, and it never stops till the end of its life is near. Inorganic bodies, such as coal, gold, iron or lead, become larger by the adding on to their

outsides of other pieces of coal, gold, iron, or lead.

When an organic body dies, it at once becomes inorganic, unless it is taken care of in certain ways I cannot now explain to you. The breath, which is the life or spirit, goes back to God who gave it, and the different parts through which that spirit did its work change into other forms and are used for other purposes. They can no longer grow from within, and the changes in them take place from without. We will not read any more about bodies from which the life is gone—you must turn to books on chemistry to learn about them. We will now begin to speak of what are called the "Lowest Forms of Animal Life," that is to say, the simplest organic bodies, or, in yet other words, the smallest creatures to whom God has given the breath of life and the power of moving about.

Let us first count up the facts we have learnt in this lesson. 1. An animal is a living breathing creature which can move about of its own free will. 2. It is impossible to say exactly what is the difference between the lowest forms of plant life and those of animal life. 3. Most plants are fixed to one place, and most animals can move about of their own accord. 4. A living body is one that can breathe. 5. A dead body is one from which the breath is gone. 6. Bodies which can breathe are called organic. 7. Organ means an instrument or a tool, and the organs of living bodies are the tools by means of which the life in the bodies acts. 8.

Bodies which have no breath are called inorganic. 9. When the breath leaves an organic body it becomes inorganic. 10. Organic bodies grow from within, and never stop growing from their birth to the end of their lives. 11. Inorganic bodies do not grow at all, but are made larger by additions to their outsides.

LESSON II.

WHAT PROTOPLASM IS.

I HOPE you now know what an animal is, and that you quite understand the word organic. I shall often use that and other words like it. Sometimes I shall speak of an ORGANISM, and sometimes of the ORGANISATION of an animal. When I speak of an organism I shall mean a body made up of living organs. When I say organisation I shall mean the way the organs of any animal are put together.

You know, of course, that there are a very, very great many different kinds of animals. No one man has seen all the forms of animal life with which God has peopled the land and water of our beautiful world, and if we could see them all as they are now, there would be new forms to study to-morrow, for all through creation changes are constantly going on, and there are no two leaves, no two insects, no two children exactly alike.

You can imagine then, how very, very difficult it is to divide the great animal kingdom into its different parts. You can see in a minute the difference between a man and a bird, or between a dog and a beetle, of course; yet if you begin at the bottom of the ladder of the knowledge of animal life by studying the lowest forms and go up and up to man, the highest form of all, you will find there is no such thing as a sudden step from one kind of animal to another. There is some one point in which men are like every other creature in the animal kingdom, and we shall find every part of that kingdom fitly framed together.

After a great many centuries of study, all naturalists have agreed to divide the animal kingdom into two great parts. One part includes animals which have no backbone, and the other all those which have a backbone. In this book I cannot tell you anything about the animals which have backbones—only of some of those which have none. I need not even tell you now what a backbone is.

We are then to learn together now something about animals with no backbones. There are such an immense number of animals without backbones that I must divide them into several parts, and tell you in this book only of a few of those that live in water. But before I begin to speak of the special animals we are to study together in this book, I want you to learn one great fact which has to do with animals of every kind, whether they live in or out of water,

and whether they have or have not backbones. This great fact is, that every animal is made up of tiny cells, or bags full of liquid, which are very much like the cells of vegetables.

The chief difference between the cells of vegetables and those of animals is this: vegetable cells grow together without any substance between them, and animal cells generally have a second substance connecting them. Here are two pictures, one of a group of vegetable,

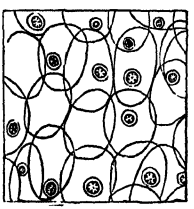


Fig. 3.—Group of Animal cells forming Protoplasm, greatly magnified.

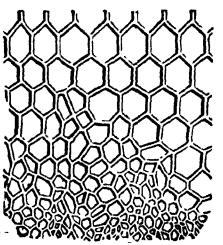


Fig. 4.—Group of Vegetable cells, greatly magnified.

and the other of a group of animal cells, with the help of which you can see the difference between the two. It is from the little round dark mark in the old cells that new cells grow. This round mark is called the nucleus or the little nut.

I want you now to learn a hard word used in speaking of the first cells of animals. This word is PROTOPLASM. It means the first moulding or

forming, and is used for the cells of animals, because all animal forms begin to be formed or moulded—in other words, to grow from cells. It is the fact that there is protoplasm in the body of a man which connects him with the very lowest form of animal life. A great many other things go to make up the body of a man, but it is in the protoplasm of that body that the life is hidden.

We now know that all animals are made up of cells, and we can see, in our third picture, what those cells are like. Next, you must learn that it is the difference in the way the cells grow which makes the different organs or parts of an animal, and then that it is the difference in the organs of animals which makes the differences between families. You remember, of course, that the two chief families of animals are those which have a backbone and those which have not. You can now write that sentence in different language, and say in one group of animals some of the cells making their protoplasm grow into the organ called a backbone, and in the other the protoplasm never grows into a backbone.

We can then understand that in the first great family the sub-divisions will be marked by some peculiarities we have not yet spoken of. I will tell you what those are in the next lesson. You have learnt enough for to-day. Let us count up the steps we have climbed, and add them to those of yesterday. 1. An organism is a body made up of living organs. 2. The organisation of an animal is the way its parts are put

together. 3. The animal kingdom is divided into two great parts, one including those animals which have a backbone, and the other those which have not. 4. All animals, whether they have or have not backbones, are made up of cells. 5. A cell is a little bag full of liquid, in which floats a round dark spot from which new cells grow. 6. This spot is called the nucleus or little nut. 7. Animal cells are very like plant cells; but the first grow together without any other substance between them, and the second are connected by some other substance. 8. The word protoplasm, which means the first moulding, is used in speaking of the cells which make the organs of animals. 9. The differences in the organs of animals are caused by the different ways in which the cells of the protoplasm grow. 10. It is the differences in the organs of animals which makes the differences in their families.

We have now taken twenty-one steps up the ladder of the knowledge of animal life.

LESSON III.

THE RHIZOPODA, OR ROOT-FOOTED ANIMALS.

NOW that you know of what all animal bodies are made up, we will take the very lowest form of water-creatures, and climb from it to the highest, learning, step by step, how one beautiful form of protoplasm succeeds another. I shall be obliged to use a great many hard words; but if I take great care to explain

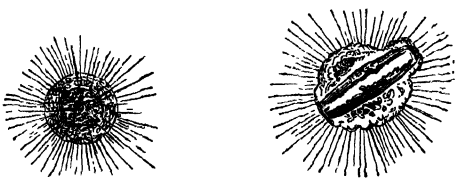
them, you, on your side, will try very hard to understand and to remember them, will you not?

The name of the lowest family in the animal kingdom is made up of two Greek words. This name is PROTOZOA. The Greek word *proto* means first, and *zoon*, animal. So that this hard word really only means first animals. All the animals in the Protozoa family are made of simple protoplasm, and have no distinct organs. They have to do all the work of living without mouths, or eyes, or stomachs, or hands, or feet. They look like transparent jelly, or jelly you can see through, with tiny dots of darker stuff floating in it. They are, many of them, so small that we can only see them with the help of a microscope or an instrument fitted up with magnifying glasses. To magnify is to make larger, and these glasses make larger the jelly we could not see without them. When you can see anything without using glasses, you say you see with the naked eye. Please remember that, as I shall often have to use that expression.

The simple jelly-like creatures of the Protozoa family are divided into several classes or groups, each of which has a Greek or Latin name describing the kind of life led by the animals included in it. You must try very hard to remember these names. The lowest division of water animals belonging to the great first-animal family, is called RHIZOPODA. This hard name means root-footed, and it is given to this group because the creatures contained in it have the

wonderful power of sending thread-like roots out of their bodies. These thread-like roots serve them as feet and arms, helping them to move about and to catch their food. There are many different kinds of root-footed animals, some of them of most beautiful forms. I can only, in this little book, describe a very few of them. The simplest of the Rhizopoda family is the Amœba, a creature too tiny to be seen with the naked eye at all.

The word Amœba means changing, and it is used as a name for the simplest of the Rhizopoda



Figs. 5 and 6.—Sun Amœba, greatly magnified.

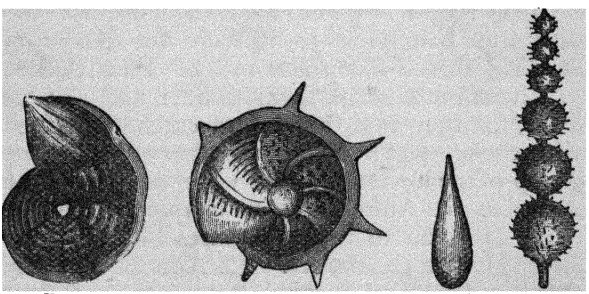
family because they are constantly changing their form. They are too small to be seen with the naked eye; but they have been watched from their birth to their death. They live separate lives, and float about in water. Instead of trying to describe them I give you two pictures of an Amœba made very much larger, to enable you to see it clearly. If you turn now to Lesson X., you will see the picture of another Amœba just going to walk into the mouth of a Rotifer. This Amœba is one of the commonest

kinds. That I give you a picture of here is not so easily found. It is called the Sun Amœba because its threads look like the rays of the sun. Remember that both these creatures are too small to be seen with the naked eye.

Amœbas feed by sucking in their food through the soft walls of their bodies. If, when you are watching them through a microscope, you drop a little ink or indigo into the water containing them, you will see this ink or indigo sink into and colour the whole of the jelly-like creatures. Their usual way of feeding is to catch tiny water plants or animals with the threads they throw out of their bodies, sucking back the prey as they draw in the threads. Amœbas have the wonderful power of adding to their numbers by each one dividing itself into two. When this happens each part becomes a separate Amœba, able, in course of time, to divide into yet another two creatures. The Sun-Amœba, on the right hand side on page 17, is dividing itself in this way.

Yet more wonderful and beautiful than the Amœbas are the Rhizopoda called Foraminiferas. The hard word Foraminifera means to carry an aperture or opening, and is used as the name of an immense number of tiny creatures living in thin shells with openings in them, through which the inhabitants send out the threads all Rhizopoda have the power of making from the substance of their bodies. The shells of the Foraminifera are made by them out of the food they swallow, much as are the eggs of birds. They are of countless different beautiful shapes, and

at low water on the sea-weed left by all over the world, though they are most numerous in hot countries where the bed of the ocean and the sand of the beach are made up almost entirely of them. From this you will know that the Foraminifera can be seen with the naked eye. It is only through the microscope, however, that you can make out all their beauty. Like the Amœbas, the Foraminifera can increase their numbers by dividing themselves in two; but



Figs. 7, 8, 9, and 10.—Examples of Foraminifera, greatly magnified.

usually, instead of doing so, they send out buds. These buds start in life as tiny round specks of soft flesh, which gradually produce shells for their protection and grow into the same shape as the parents from whom they sprung. Here are some pictures of Foraminifera in their beautiful covering, made larger than life for you to see their shapes quite clearly. In these pictures all the creatures are at rest. You must imagine for yourselves how they look when the dwellers

in the shells are all sending out their threads in search of food.

To-day we have learnt: 1. The lowest family in the animal kingdom is called Protozoa. 2. Protozoa means first-animal. 3. The animals of the Protozoa family have none of them separate organs. 4. They are many of them too small to be seen with the naked eye. 5. The name of the lowest division of the lowest family of water animals is Rhizopoda, which means root-footed. 6. This name is given to it because all the creatures belonging to it have the power of sending thread-like roots out of their bodies. 7. These roots serve them as feet, and also as arms, for they both move and catch their food with them. 8. The lowest member of the lowest group of the lowest family of water animals, is the Amœba. 9. Amœba means changing, and this name is given to these creatures because their forms change constantly. 10. Amœbas feed by sucking their food through the outsides of their bodies. 11. Amœbas have the power of adding to their numbers by dividing themselves in two. 12. The name of the group of the first life family next above the Amœba, is Foraminifera, which means to carry an opening. 13. The Foraminifera live in shells they make for themselves, and send out thread-like roots from holes in these shells. 14. They can increase by division; but they generally grow from buds on the bodies of their mothers.

We have climbed thirty-five steps together now.

LESSON IV.

SPONGES AND HOW THEY GROW.

FIRST cousins to the Foraminifera, though a good deal higher up than they in the animal kingdom, are the Sponges, which, when their life is over, are of so much use to us all. Of course you all use sponges, and know how they look when you use them, but I do not suppose many of you have any idea of their appearance when they are alive. I give you here a picture of a piece of a living fresh-water sponge, which will give you some faint notion of what it was like when in its wet home. You see that this sponge is covered with small holes, with here and there a larger opening. Now if you put a small piece of this sponge under the microscope you would see that the small holes lead into small passages, which in their turn all lead into each other, and that the large holes lead into large tubes.

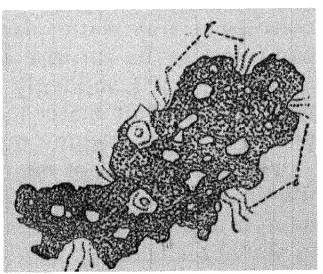


Fig. 11.—A piece of a fresh-water sponge, life size.

The small passages are all entrances into the large tubes, and form altogether a perfect net-

work, like the large and small streets of some great city. The material of which all these passages is made is a very fine tissue or woven substance, made by the sponge creature out of its food after that food has been swallowed and digested. In this wonderful woven home live a number of creatures with soft shiny bodies like those of the Amœbas, able like them to throw forth thread-like hairs from their bodies, with the help of which they sweep water in and out of the passages of their city, this water flowing in at the small passages and out at the large ones. One of our greatest naturalists has likened a living growing sponge to a city under water, with the inhabitants lining the passages through which the food they need is swept in. This food consists of tiny water plants or animals, and we can imagine the surprise of some little creature at finding itself suddenly rushing into darkness with a current of water to be seized in a narrow passage by a soft shiny mass.

The tissue home of many sponges is so closely woven that it is protection enough to its inhabitants; but many sponges have the power of further shielding themselves by sending out spicules or spines made from the lime or the flint they get out of the water. These spicules in the flint sponges are of all manner of different and beautiful shapes, and are arranged in lovely patterns, so lovely that it is difficult to believe them to be the work of creatures that cannot see. The fact is their beauty is only an accident, for the shape has always a special meaning, turning one way

to keep enemies out and another to prevent the escape of prey. Here is a picture of a number of sponge spicules such as protect the eggs of the sponge, of which I have given you a picture, and on page 24 one of a salt-water sponge. Both are of course made very much larger than they really are, for they are so small that they look like the points of fine needles.

I said in the first sentence of this lesson that sponges are a good deal higher in the animal

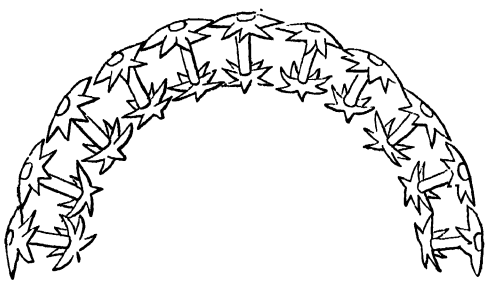


Fig. 12.—Group of Sponge spicules protecting eggs, greatly magnified.

kingdom than their cousins, the Foraminifera. The making of two sets of passages and the production of spicules are, however, not much more wonderful than the manufacture by Foraminifera of their delicate shells. It is the fact that the sponge creatures use different parts of their bodies for the work of living and for that of building, which places them higher than the other Rhizopoda. Whilst one set of cells is

building up tissue and making spicules, another set, called by the author of "Life and her Children" whip-like cells, are busy getting food and air to nourish the whole body by waving to and fro the hairs or cilia they have the power of sending out. We cannot say that sponges have separate organs, but by thus making different parts of their bodies do different work they

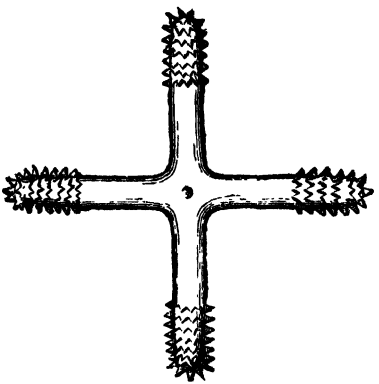


Fig. 13.—Single Sponge spicule, greatly magnified.

shadow forth the separate organs or instruments of those higher than themselves in the great kingdom of which the countless different members may truly sing, "all one body we."

You know now how the city of a living sponge is built up, and how its grown-up inhabitants spend their lives. Next let us learn how their children are born into the world. In

other words how sponges increase their numbers. Like so many other of the lowest members of the animal kingdom they come into life in several different ways. By budding like the Foraminifera, by self-division like the Amœbas, and by the sending out of eggs. A naturalist who had long kept in a glass vase a piece of such a sponge as I have shown you in fig. 11, threw it away because it was dead, and becoming inorganic it was poisoning the water for the other creatures in it. Two years afterwards some young sponges appeared at the bottom of the vase. They were as large as a pea when their owner first noticed them, and they had fastened themselves to a bit of weed. Our naturalist took this bit of weed and stuck it on to the side of his glass vase so as to watch the baby sponges grow. Presently small and large holes appeared on the surface of each, duckweed was drawn in at the small ones and sent out, with all the nourishment taken from it, at the large ones. Then eggs began to grow inside the passages, and rows of spicules were formed around them. Five months later these eggs were ready to be sent forth on their own lives, and after growing larger and larger for ten days they burst, and from each came forth the soft slimy body of a new sponge. Each of these bodies set to work to make tissue and spicules, and a new colony or family was very soon growing up. Now and then this new colony sent a little bit of its living flesh out into the water, and from it grew another sponge family. You see then that

this one sponge increased in two ways, by self-division and by the sending out of eggs. Very likely some of the grandchildren of the first sponge are now trying also the third plan, and sending out buds.

To-day we have learnt:—1. Sponges are first cousins to Foraminifera, but higher than they in the animal kingdom. 2. Sponges make for themselves homes of fine tissue, or woven material, out of their food. 3. These homes are divided into two sets of passages, small ones leading into each other, and large ones to which all the smaller ones lead. 4. The sponge creatures line these passages, sending forth from some of the cells of their bodies thread-like hairs with which they sweep water and food into the small and out of the large passages. 5. Sponges feed on tiny water plants and animals. 6. Some sponges protect themselves from injury with spicules, which they make out of the lime they swallow with their food. 7. These spicules are of lovely shapes, each shape specially fitted for the work it has to do. 8. It is the dividing of the work of feeding and that of making their homes and spicules between different parts of their bodies that places sponges higher than Amœbas or Foraminifera. 9. Sponges increase their numbers in three different ways: by budding, by self-division, and by producing eggs. 10. Some sponges increase at different times in all these different ways so that one sponge may be the parent of many families.

We have now climbed forty-five steps up the ladder of the knowledge of animal life.

LESSON V.

ABOUT SOME INFUSORIA.

I HAVE still to tell you of one more group of beautiful creatures belonging to the great Protozoa or first-animal family, which differ in several important peculiarities from the Amœbas, Foraminiferas, and Sponges. The name given to these new groups is, as usual, long and hard. It is INFUSORIA, and it means that which is infused, or poured into. This long name is given to these creatures because they swarm in any infusion or liquid which contains animal or vegetable matter and is left exposed to the action of the air. They collect on water-plants, sticks, or anything else to which they can fix themselves. A few of the Infusoria are large enough to be visible to the naked eye, but most of them can only be seen by the help of the microscope. They exist in the sea in countless millions, and a single drop of water contains thousands.

Every Infusorian consists of a jelly-like transparent body, enclosed within a thin skin, which is formed on its outside surface. The first peculiarity distinguishing it from its more lowly cousins is, that it has a distinct mouth, opening into what is called an ALIMENTARY CANAL. Aliment means food, and canal, passage, so that

you can understand that an alimentary canal is a passage for food. This passage for food leads straight into the soft inside of the body of the Infusoria, instead of into a stomach, as in creatures higher up in the scale of animal life. If you watch an Infusorian through a microscope, you can see the change of the little lumps of food it has swallowed into nourishment fit for making new cells; or, in other words, you can see the change of food into flesh. A second peculiarity of the Infusoria is the possession of what is called an ANUS; that is to say, an opening in the body, through which the food from which all nourishment has been taken is allowed to escape. This escape you can watch through the microscope, as well as the making of new flesh, and from watching it you can get some idea of what goes on in your own stomach after dinner. All the higher animals have such openings, so you see that the Infusoria resemble them in that as well as in having mouths and food passages. The anus of the Infusoria is near the mouth, but, like the openings in the bodies of the Amœbas, it disappears entirely when it is not being used.

The whole of the surface of the bodies o most Infusoria is covered with fine hairs called cilia, which are always in motion, and with the help of which the creatures they belong to swim about and sweep their food into their mouths; others send out root-like threads which serve the same purpose. All feed on each other and on tiny water-plants invisible to the

naked eye. I will give you a picture of a group of Infusoria to help you to understand what they are like, and how they live, but it would take an immense number of pictures to do justice to the great variety in this wonderful family.

My picture shows you two different kinds of

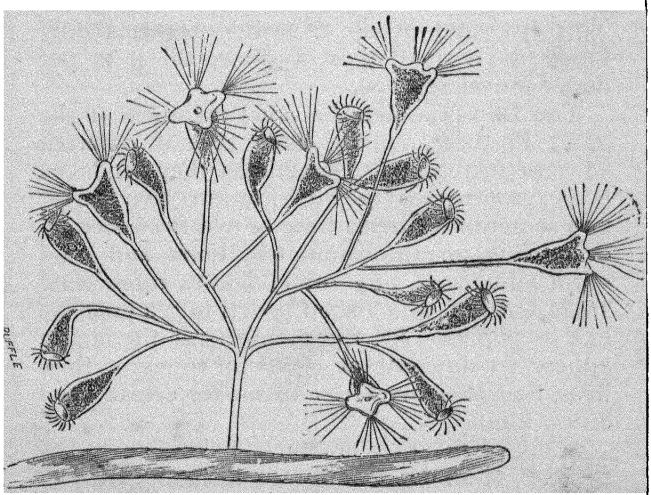


Fig. 14.—Group of Acineta and Vorticellæ, greatly magnified.

Infusoria living together,—the Vorticella and the Acineta. Both grow from stalks which they fasten on to some water-plant, and both send out long threads to catch their food, keeping perfectly still till it is within reach, when they begin to move their threads about, drawing the plant or

animal they want to eat through the soft substance of their bodies. You can tell the Vorticella from the Acineta by the difference in its threads; those of the first spring out all round the body, and are all of the same length; those of the other grow out in two tufts, and are much longer than they ever are in the Vorticella. This beautiful group of water-creatures only looks like a small dab of slime, till it is put under the microscope.

The Infusoria, like the other members of the great Protozoa family, have several different ways of increasing. Sometimes they send out buds; sometimes they divide into two parts; and sometimes, after a time of rest from feeding or moving, an Infusorian will burst and send out a number of tiny round bodies resembling seeds, each of which soon grows into a creature like its parent. All the members of the family appear so different at different times in their lives, that they are often taken for creatures of a new kind.

Many of the tiny creatures belonging to the great First-animal Family we have been learning about have the wonderful power of sending out light from their bodies, though they cannot see themselves. No one yet quite understands how this light is made, but it is supposed to be the result of a change in the tissue or flesh of the creature giving the light; and that this change comes from the action of air and sunlight on the tissue. In many parts of the ocean the sea is so full of tiny light-giving animals that it gleams as if it were on fire.

To-day we have learnt:—1. The group next above the Sponges in the Protozoa family is called Infusoria, a name meaning infused or poured into. 2. This name is given to this group because the creatures belonging to it swarm in any infusion or liquid containing animal or vegetable matter. 3. The Infusoria have mouths leading into alimentary canals. 4. An alimentary canal is a passage for food. 5. This canal leads straight into the body of the animal to which it belongs. 6. Every Infusorian also has an anus or opening in the body, out of which is sent the food from which all nourishment has been taken. 7. The anus is near the mouth, and disappears when not in use. 8. The bodies of all Infusoria are covered with cilia or hairs, with which they move and catch their food. 9. The Infusoria have several different ways of adding to their numbers. 10. All Infusoria look very different at different times in their lives.

We have now climbed fifty-five steps altogether.

LESSON VI.

THE LIFE OF A HYDRA AND OF A MEDUSA.

WE now take a great step up the ladder of the knowledge of animal life, for we pass from the creatures belonging to the lowest family of all to those in the second family, all of which can be seen without the help of a micro-

scope, and the name of which is HYDROZOA. The first meaning of this name is water animal, and it was first given to the numerous animals of this second family because they all live in the water. It has now come to mean more and less than this, for it is only given to certain water creatures whose bodies are divided into two layers of flesh—each layer made up of a great number of cells such as I described to you in my first lesson. The Amœbas and other Protozoa you know had no such division in their bodies.

A second, and most important thing distinguishing the Hydrozoa from the Protozoa is, that they all have a kind of stomach separate from the rest of their bodies. A stomach is a bag in which food is received and made ready, by what is called digestion, to do the work of nourishment. As we go higher and higher up our ladder we shall find this bag divided into more and more different parts, each part with a special work to do. You will remember that the lowest animals have no such separate organ or instrument as a stomach, for doing the work of digestion. Do not forget that digestion is the division in the stomach of the food swallowed, and its preparation for the different kinds of work it has to do.

There are a great many different members of the Hydrozoa family. In this book I can only describe two of them — the common Hydra, living in fresh water, and the Medusas, living in the sea. The first is about three-

quarters of an inch long, and has the power of sending out of its outer skin long thread-like arms, with which it catches the creatures on which it lives, and hugs them to death. These thread-like arms spring from just below the mouth of the hydra, and soft as they are, they are very formidable to the enemies of their owner, for they numb the life in the creatures

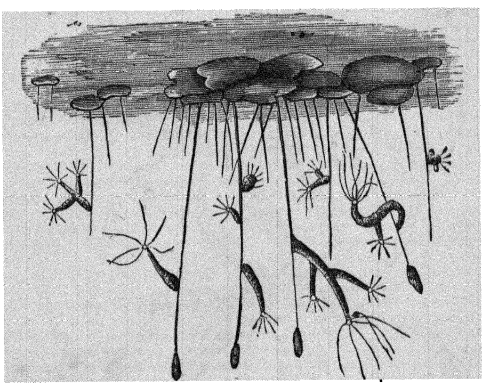


Fig. 15.—Group of Hydra attached to Duckweed, magnified.

they catch. To numb means to take away feeling so that the poor creatures eaten by the hydra do not suffer much pain. It has been discovered that the numbing is done by a collection of very fine stinging cells, forming, what looks under the microscope, like a very thin hair. This thin hair can be sent out of the threads only once. It can never be used a

second time, but dies itself when it gives death. If you watch a hydra at work, through a microscope, you will be astonished at the quickness

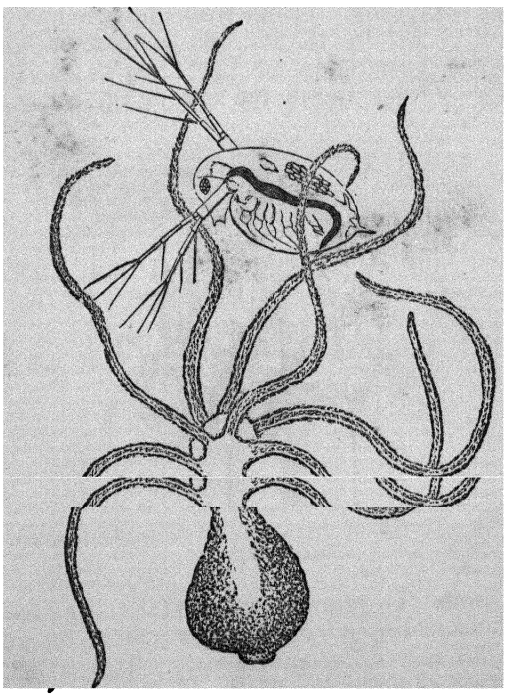


Fig. 16.—Hydra attacking Water-flea, very greatly magnified.

with which it darts its hair through its prey, as if it did not mind wasting these hairs at all.

When the prey is dead the hydra draws it into its mouth with its long arms. I give you a picture of a hydra struggling with a water-flea. Both are made very much larger than life, of course. The gentleman who made this drawing tells us that the water-flea was too much for the hydra, and managed to escape.

For a very long time no one knew how hydras were born into the world. At last, however, a patient naturalist, who had long watched a hydra in a glass case, saw the growth of a tiny egg on its body, below the mouth and arms. Three days after the discovery of the egg, it was loosened from the body of the mother and fell to the bottom of the water. When it first appeared it was cream-colour—it had now turned to bright orange. It remained at the bottom of the water for fifty-five days, and the only changes which took place in it during that time were, that the outside skin became rough and the shape changed from round to oval. At the end of the fifty-five days the egg cracked and a baby hydra pushed out part of a soft, transparent, crystal-like body, quite round and smooth. Two hours afterwards, this baby began to put out threads, and in seven hours its shape was just like that of the mother hydra, only much smaller. This baby hydra took no food till it was more than a month old. It is now known that hydras do not always come from eggs, but grow out like branches from the bodies of grown-up creatures. From these branches spring yet younger branches; so that

sometimes quite a family tree is made. In fig. 15 you can see several young hydras growing from their mother's body.

The hydra, though it has no legs or fins, moves about in the water at its own free will, guiding itself with its long arms as if they were oars. If you turn a hydra inside out, it lives on as if nothing had happened; if you cut off its arms it throws out others, and if you cut it in half each half becomes a separate hydra. In fact, these little creatures cling to life so desperately that it is almost impossible to kill them.

It is now time to speak of one of the medusas, also called the sea-jellies or sea-blubbers. These creatures, like all the rest of the Hydrozoa, have bodies divided into two parts, stomachs for the reception of their food, and long arms which they can draw out and in at will, with which they swim about, and catch, and numb their prey. They are, however, very much larger than the hydras, their shape is quite different, they have regular passages for carrying their food into their stomachs, and they have, which the hydras have not, the power of sending out light from their outer skin, looking, on a dark night, like balls of fire. Here is a picture of one of the commonest medusas, to show you how the body is formed, and how it looks when it is swimming about. The whole creature is quite transparent, and the motion given to all its parts by every breath it breathes can be watched quite easily. At the edge of the upper part, or as it is called the umbrella, from which grow the

arms, are a number of round, coloured spots, supposed to be eyes, and also a number of bead-like bumps supposed to answer the purpose of

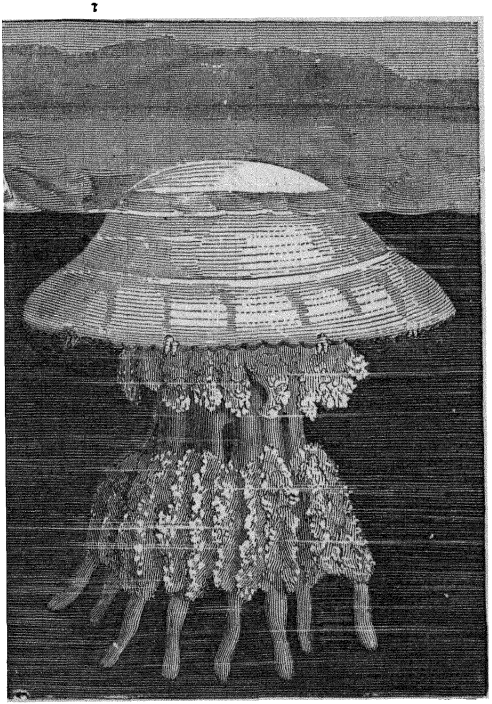


Fig. 17.—Medusa or Jelly-fish, life size.

ears. See how we are getting gradually higher and higher up the ladder of the knowledge of

animal life! We have not yet spoken of a heart, or brain, or lungs, but we are describing a creature, one of a large family, which has something resembling our own organs of sight and hearing, passages connecting the stomach with the mouth, and strong arms for swimming rapidly about. Baby medusas are born from eggs, and also from buds on the body of the mother. When they first start forth on their travels they are very different from their parents, looking like tiny worms with pointed tails and a mouth surrounded with thread-like hairs. They begin their lives by fastening themselves to some stone or rock, where they often remain till they themselves send out new buds, from which, in course of time, grow perfect medusas. It is only by watching the actual growth of a baby to a full-grown medusa that one can realise it to be the same creature.

I have chosen a hydra and a medusa to describe because both can easily be found. There are hydras in every fresh-water ditch, and jelly-fishes are left by the tide on the sands of many parts of the coast of England; they are very annoying to bathers, whom they often sting as they do their prey, causing a terribly painful sensation.

Let us count up our steps of to-day. 1. The family next above the Protozoa is called the Hydrozoa. 2. Hydrozoa means water-animal, and was first given to the creatures belonging to this family because they all live in the water. 3. It is now only given to certain creatures

whose bodies are divided into two layers of flesh. 4. The hydrozoa have all stomachs separate from the rest of their bodies. 5. A stomach is a bag in which food is received and made ready by digestion to nourish the body. 6. Digestion is the division of food and its preparation for the different kinds of work it has to do. 7. The hydra lives in fresh-water ditches. 8. It has thread-like arms containing fine stinging cells like very thin hairs. 9. With the arms it catches its food and draws it into its mouth. 10. With the stinging cells it numbs or takes away the feeling of its victim. 11. Hydras can be cut to pieces or turned inside out without being killed; any part cut off will grow into a new creature. 12. Hydras increase from eggs, by budding, or by the growth of new creatures from pieces cut off old ones. 13. Medusas, or jelly-fishes, are like hydras in their organs but not in appearance. 14. Medusas are of different sizes, and when in the water look like open umbrellas with long arms dangling from them. 15. These arms contain stinging cells which numb the prey caught in the arms. 16. Medusas give out light in the dark, and are supposed to be able to see and hear. 17. They grow from eggs and from buds, and look very different from their parents for the first few months of their lives.

We have climbed seventy-two steps now.

LESSON VII.

SEA-ANEMONES AND HOW THEY LIVE.

ONE little step further up the ladder and we are at the entrance of a very beautiful division of the great animal kingdom, for we are to learn now about the lovely Sea-Anemones and Coral-makers, which both belong to a family called the Actinozoa, a name meaning ray-animals, and given to it because all its members have arms which look like rays when they are stretched out. We will take the soft naked sea-anemones first, and then their cousins with the wonderful coral armour.

You remember, of course, all you have just read about the hydras and medusas. Like them, the sea-anemones have two layers of flesh, the inside and the outside; like them, too, they have mouths surrounded with thread-like arms which they can draw in and out at will, and with which they catch their food. Like them, again, they have stomachs separate from the rest of their bodies, but that which places the sea-anemones higher up than the hydras or medusas in the animal kingdom is that the stomach is connected with the rest of the body by a kind of skin, and leads into a chamber where the digested food is received. You cannot turn a sea-anemone inside out without killing it, for to do so would break

the connection between its stomach and the rest of the body. Anemones also differ from hydras and medusas in having a liquid flowing in and out amongst the cells of their bodies which is something like the blood of the higher animals. Most of the anemones remain all their lives fixed to rocks by the lower end of their soft bodies, but some few swim about freely. This picture of a sea-anemone, the size of life, with all its arms out, will give you a better idea of how these creatures

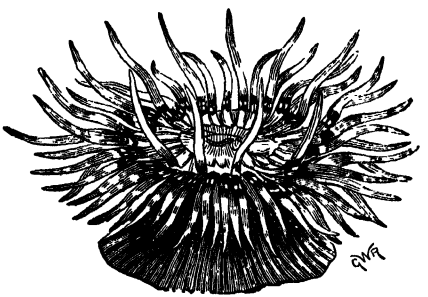


Fig 18.—Sea-anemone, life size.

look than any description will, but no picture can truly represent their lovely colours, which are as numerous as those of the rainbow. Round about the mouth and between the arms of many sea-anemones are a row of tiny little bumps, like beads, which some naturalists think are eyes. If they are, these eyes form another great distinction from most of the creatures we have yet read of; but until more is known we cannot be sure that sea-anemones can see.

I have something very strange and wonderful to tell you now about the sea-anemones. Their children are born into life in their arms and pass from them into their stomachs with their food. There the soft round baby anemones remain for a little time, and then they are flung out into the sea through the mouth of their mother with the part of the food which is useless. All animals you know reject or throw out part of the food they eat; but the anemones are the only creatures which send their children out with it. When the baby anemones find themselves in the water they roll about till they see a rock to suit them, when they settle on it for life and quickly send out arms like those of their parents. Anemones not only digest their food and nurse their young in their stomachs, they also breathe with it, for it sucks in the air contained in the water, which is again sent out through the mouth when the anemone has taken from it what it needs. The higher animals, as we shall see, have separate organs for breathing; but to have one organ such as a stomach is a great advance in the scale, is it not?

Sea-anemones, like hydras, have the power of numbing their prey. When they catch a worm it wriggles a little and then becomes quite insensible and motionless. Sea-anemones have tiny swords or spears made up of stinging cells like those of the hydras, only more powerful than theirs. These tiny swords are kept in the tops of their arms, and when they have caught their prey they send out these

swords and pierce with them the flesh of their victims. These spears are supposed to be poisoned. A naturalist once succeeded in taking some of them from a living anemone by giving it a bit of india-rubber to eat. The spears stuck to the india-rubber, and when they were examined under the microscope they were found to be each like a watch-spring. They are kept coiled or twisted up in their cases till they are needed, and then they are pushed suddenly out by tiny organs in the bottom of the cases. We have left behind creatures only to be seen with the help of the microscope, but the beauties of the separate parts of the Actinozoa cannot be understood without its aid.

Anemones are very greedy creatures, and will eat themselves to death if they get food enough. They generally feed on Protozoa and shrimps or crabs; but when they are kept in glass cases they will try and swallow anything offered to them. An anemone was once seen to swallow a shell much bigger than itself. This shell cut the greedy creature in half; but instead of dying it actually threw out a mouth on the under side of its body, so as to reach its stomach from the lower end! If the stomach of an anemone is left unhurt you can cut it to pieces without killing it, for it will send out new arms to take the place of those destroyed.

It is only when they are in the water that the beauty of the sea-anemones can be seen. At low tide, when the rocks on which they have settled are left dry, they draw in all their arms

and look like shapeless masses of jelly with a wrinkled hole at the top. As the water rises again they seem to give a sigh of delight at its return; the jelly swells, the mouth opens, and the delicate arms spread out. Whether they can see or not they have certainly some sense to tell them when the time of their inaction is nearly over, for they begin to change as soon as the first ripple of the returning waves moistens the sand about their rocks.

Are not the facts we have learnt to-day beautiful? Let us count them up before we read about the coral-makers:—1. Sea-anemones and coral builders belong to a family called Actinozoa. 2. This name means ray-animals, and is given to the anemones and coral-makers because they all have arms which look like rays when they are spread out. 3. What places anemones higher than hydras or medusas is that they have stomachs connected with the rest of their bodies by a kind of skin, and leading into a chamber where the digested food is received. 4. Anemones have a liquid flowing in and out amongst the cells of their bodies which resembles the blood of the higher animals. 5. Most of the anemones spend their lives fixed to rocks, but some can move about freely. 6. Baby anemones are born in the arms of their mothers and pass from thence into the stomachs of those mothers, whence they are sent out with the food from which all nourishment has been taken. 7. Anemones begin their lives by rolling about in the water till they find a rock to suit them, when

they settle down till their death. 8. Anemones breathe with their stomachs, sucking in air and sending it out again. 9. Like hydras the anemones have the power of numbing their prey by stinging it with tiny spears coiled up in their arms. 10. These creatures feed on crabs, shrimps, &c., and are very greedy. 11. Some naturalists think the bead-like bumps between their arms are eyes.

We have now climbed eighty-three steps up our great ladder.

LESSON VIII.

CORAL-MAKERS AND HOW THEY GROW.

AS I said at the beginning of the last lesson, the Coral-makers are first cousins to the Sea-Anemones. Like them they consist of soft, jelly-like bodies divided into two parts, with a stomach connected with the outer wall of flesh, and with a mouth surrounded by arms capable of being drawn in and out. What places the coral-makers apart from the sea-anemones is that they live in families instead of separately, and that they have the power of making homes for themselves out of the food they eat. Each creature in a coral family is called a POLYP, a word which means many-footed, and it was given to the coral-makers at a time when what we now call their arms were called their feet. There are an immense number of different kinds

of coral-makers. I can only tell you about a few of them; but I hope what you learn in this book will help you to study the other members of this wonderful family for yourselves.

I have told you that each polyp in a coral family has a soft body, resembling that of a sea-anemone. I must now add that coral-makers are very, very much smaller than anemones, and that, although each creature can be seen

Fig. 19.—Piece of Sea-organ Coral showing structure, magnified.

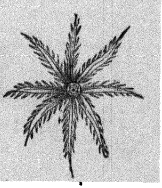


Fig. 20.—Single polyp of Sea-organ, magnified.

with the naked eye, the help of the microscope is needed to examine all its beauties.

I think the best way to make you understand the life of a coral family is to give you some pictures, first of the single polyp, and then of a number of polypes in a group. My first picture (Fig 19) is of a single polyp of the family called the Sea-organ, because, when a number of these polypes have made their homes together, these

homes look like the pipes of an organ. In this picture the polyp is made very much larger than life, that you may clearly see its divisions. It has all its arms folded up. In my second picture you see the head alone of the same polyp, made a little larger than life, with all the arms spread out. My third picture (Fig. 21) shows you the homes of two such polypes, with the creatures just about to put out

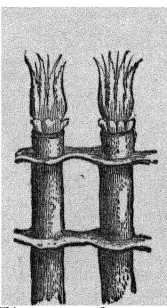


Fig. 21.—Sea-organ Coral with polypes about to spread out their arms, magnified.

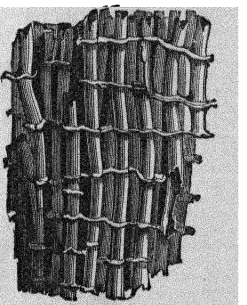


Fig. 22.—Group of Sea-organ Coral after the death of the coral-makers, natural size.

their arms, made very much larger than life, and my fourth picture shews a large number of such homes after the polypes have died and left them empty.

I now give you a picture of another kind of coral, from which the living creatures are gone. I have chosen it because it is one of the many different kinds which are of such great import-

ance to the world as the materials of new land. The tiny soft creatures which live in this and other kinds of branching coral spend their lives

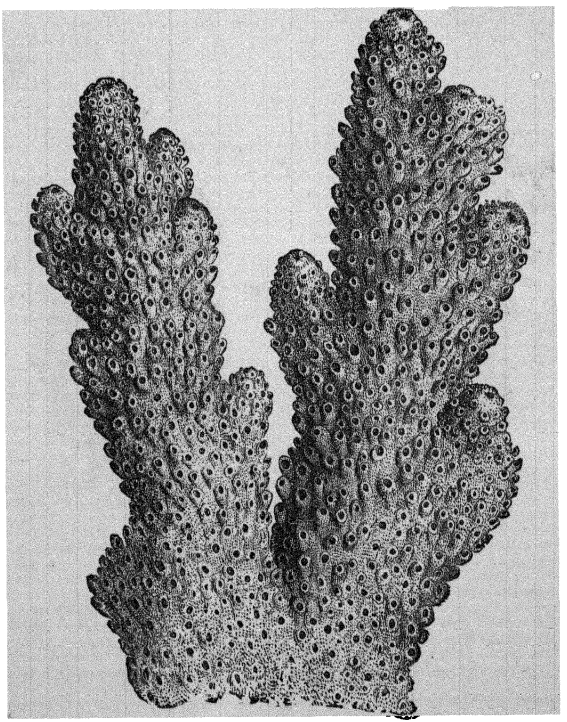


Fig. 23.—Madrepore Coral, natural size.

in making this hard glistening material, and when they die others build on their work, till at

last the top of the ocean is reached. The first branch of coral which rises above the sea is the beginning of a new island; other branches in their turn snew their tops beside it, till by degrees there is room for a collection of sea-weed and shells, which are caught and held fast in these branches. Then the birds flying past, and the wind rushing by, bring seeds, which take root amongst the shells and sea-weed. These grow quickly in the warm sunbeams and pure air, and before very long an island is formed fit to be the home of men. Thousands of islands in the Pacific Ocean are made by coral-makers. In another little book, "Forms of Land and Water," you will find pictures of the first beginnings of different kinds of coral islands.

We have now to do only with the creatures which make these islands; so, instead of saying more about them, we will learn how the polypes are born and begin their work. There are two ways in which new polypes come into life. The first is by what is called budding, that is to say, a bud springs from the side of the body of the mother, and from this bud grows a polyp which remains fastened to its mother for the rest of its life. The second way is very much like the birth of an anemone: the baby polyp is born from an egg, and sucked with the mother's food into her stomach, where it lives for a short time, and is then sent out of her mouth with her rejected food to take care of itself. It looks like a tiny white worm, with one end pointed and the other fringed with hairs. It swims with

its mouth behind till it finds a rock it likes, when it flattens out its pointed end and fixes itself with it to the rock. Here is a baby polyp which has just chosen the spot for its future home. It then at once begins to secrete, that is to say, to separate the material for making coral out of the food it swallows. This material is a kind of lime, and is the same as is used by the Foraminifera for their shells, and by birds for their eggs. When a polyp remains on the mother polyp it begins to work directly after its birth, without the delay caused by having to find a new home.

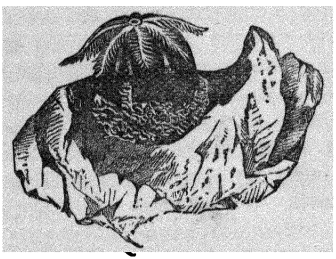


Fig. 24.—Young Coral Polyp just settling down, magnified.

The bodies of the coral-makers do not remain separate long after birth, but run into each other, so that it is impossible to separate them into single polypes. The framework of their homes, too, is all joined in one, so that you cannot tell how much work each polyp has done. Every now and then the polypes rest a little, and when they do so a joint is made in the coral building. Some corals make the building inside their bodies, others both inside and outside, but whether it is inside or both in and

outside of the flesh, it serves the same purpose: to protect that flesh from injury.

We have learnt to-day:—1. Coral-makers are first cousins to anemones, with stomachs connected with the rest of their bodies, and mouths surrounded by arms which they can draw in and out. 2. They differ from their cousins in living in families instead of separately, and in their power of making homes for themselves out of the food they eat. 3. Each creature in a coral family is called a polyp. 4. Polyp means many-footed, and the name was given to the coral-makers when their arms were called feet. 5. Each polyp has a soft body, very much smaller than that of the anemone, though having all its characteristics. 6. These tiny soft creatures spend their lives in making a hard material called coral. 7. When they die others build on the work they have left, till at last the top of the sea is reached. 8. When a number of groups have reached the top of the ocean sea-weed and shells are caught in them, birds drop, or the wind brings, seeds, and the beginning of an island is made. 9. Some coral-makers make the coral inside, and some both inside and outside, of their bodies. 10. Polypes increase by the growth of buds on the mother polyp, and they are also born from eggs, which are sent out of the mouth of the mother with her rejected food. 11. Young polypes look like worms with pointed tails, and heads fringed with hairs. 12. After swimming about for a short time a young polyp fixes itself on a rock, and

begins to make coral. 13. The bodies of coral-polypes do not remain separate long after birth, but run into each other. 14. The framework they make is also joined in one.

We have climbed ninety-seven steps now.

LESSON IX.

ABOUT SOME POLYZOA.

THE family I shall tell you about to-day resemble in some things both the coral-makers and the anemones, but, though they are very much smaller than either, they are much higher up in the scale of animal life. The name of this new family is Polyzoa, which means many animals, and it is given to the creatures belonging to it because a great many of them live together. Each creature of the groups living together is so small that it cannot be clearly made out without the help of a microscope; but as a great many collect in each group the whole colony can easily be seen. Some of the Polyzoa live in fresh and some in salt water. I give you a picture of a group called the Plumatella, taken from the stem of a water crow-foot, which only grows in fresh water. This picture shows the group made a little larger than life.

When I said that the Polyzoa resemble the sea-anemones and the coral-makers in

certain respects, yet were higher up in the scale of animal life, you understood, of course, that they have mouths and stomachs; for if they had not they would be lower instead of higher than our friends in the family beneath them. Now we have to find out in what the Polyzoa differ from the sea-anemones and coral. One chief distinction is the possession of an INTESTINE into which a passage leads from the stomach. An Intestine is a tube or passage leading from the stomach to the anus. I have already told you that a stomach is a bag in which the food eaten is prepared, by what is called

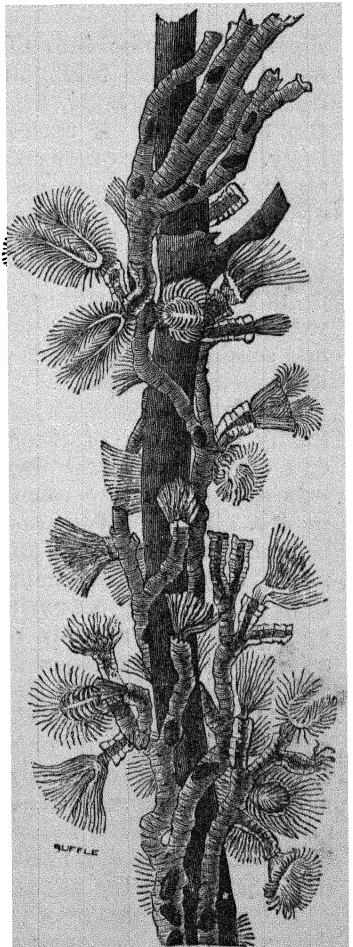


Fig. 25.—Group of Plumatella, magnified.

digestion, to pass into the rest of the body; and I have also told you that an anus is an opening in the body from which that part of the food which is useless is sent out of the body. The only other creatures we have learnt about yet which have such openings are some of the Infusoria. In Lesson VI. you learnt tnat certain Infusoria have an anus near the mouth which disappears when it is not in use. This is not the case with the Polyzoa, the anus with them is always there, and the taking in and sending out of food goes on as regularly with them as with us.

The intestine of each member of the Polyzoa family opens out of the stomach at the lower end of the body and then turns suddenly upwards, ending in an anus, or opening, near the mouth. There is yet another great distinction between the Polyzoa and the creatures beneath them in the scale of life. They have a well-developed NERVOUS SYSTEM. A nervous system is a chain or network of nerves, and nerves are organs or instruments of feeling. All the higher animals have two sets of nerves, or organs of feeling, and the lowest animals have either none at all, or only very slight ones, so that the feelings of the creatures they belong to must be very faint. The nervous system of the tiny members of the Polyzoa family, however, is of a kind to place them nearer to the human race than they are to the anemones or the corals!

The nervous system of the Polyzoa is between the mouth and the arms, and looks, when seen

under the microscope like a knotted bunch of string. From this knotted bunch very thin threads are sent out in every direction, carrying the feelings of the creature they belong to all over its body.

All the members of the Polyzoa family make for themselves homes in which to live. These homes look like the structures built up by the coral-creatures, but they are not nearly so hard, and the chambers or cells in them are always quite separate, to suit the needs of their owners, each of which leads a life for itself, another thing greatly distinguishing them from the coral-polypes, with their bodies running into each other. My picture shows you a great many of these homes, some with the makers' head and mouth outside, others with the owner drawn right down into its cell. At the top part of the picture you can clearly see the beautiful horse-shoe shape of the mouth and head, with all the hairs spread out. The animal fastens itself to its cell with bands and threads thrown out of its body here and there. These bands can be cut through without injuring the creature. Some of the Polyzoa have a peculiar organ, rather like a beak, fixed to the outsides of their cells. No one has yet found out the real use of this beak; for though the creature it belongs to can catch tiny animals with it, it is too far from their mouths for them to be able to eat the animals. Some naturalists think the smell of the dead bodies held in these beaks draws the creatures the Polyzoa wish to eat within reach of their

mouths, so that they act as a kind of bait or temptation. Perhaps some of you who read this lesson may discover the truth when you are old enough to study for yourselves with the microscope.

Baby Polyzoa are born into the world in many different ways. Some grow from buds on their mothers' bodies, others are born from eggs, and others are sent out naked from the anus of the mothers, and begin their lives by rolling about in the water till they find some weed on which to build their homes. The little ones which are born from buds often remain connected with their mothers all their lives.

Are not the facts we have learnt to-day wonderful and beautiful? Step by step we have slowly climbed from the creatures with no special organs with which to do the work of living, to a group with mouths, stomachs, intestines, anuses, and nerves, and we now stand at the door of a new kingdom, with inhabitants gifted with powers yet higher and nearer to our own. The facts learnt to-day are,—1. The Polyzoa family resembles in many respects that of the Actinozoa, but though its members are much smaller than coral-makers or sea-anemones, they are a good deal higher in the scale of animal life. 2. Each animal is so small as to be hardly visible to the naked eye. 3. The colonies form lovely groups, some living in fresh and some in salt water. 4. It is chiefly in having an intestine, or passage leading from the stomach to the anus, that the Polyzoa differ from the Actinozoa. 5. A second

great distinction between the Polyzoa and the creatures beneath them is their possession of a nervous system. 6. A nervous system is a chain or network of nerves. 7. A nerve is an organ of feeling. 8. All the higher animals have two sets of nerves. 9. The nervous system of the Polyzoa is between the mouth and the anus. 10. The members of the Polyzoa family make homes in which to live. 11. These homes are not so hard as those of the coral-makers, but each cell is separate. 12. Each creature lives a distinct life. 13. Some of the Polyzoa have a peculiar organ like a beak, with which it catches the animals. 14. The Polyzoa are born in several different ways, the chief being from buds and eggs. We have climbed one hundred and eleven steps now.

LESSON X.

SOME TINY CREATURES WITH WATER-WORKS.

IT will, I think, surprise you after reading about such creatures as the sea-anemone and others, for me to tell you that our next step not only takes us higher up the scale of animal life but back again into the world of invisible water creatures. You are to learn to-day about the Rotifers, or little wheel-animals, so called because the threads round their mouths make a movement in the water about them resembling a wheel. The rotifers are some of them large

enough to be just seen with the naked eye, but most of them are invisible without the microscope, and the beauties of even the largest can only be made out with its help. They live all over the world, in both fresh and salt water, hot and cold climates, and they have everywhere caused eager discussion amongst naturalists as to their true place in the great animal kingdom. I have thought it best for this reason to give them a Lesson to themselves.

I give you here a picture of a rotifer fastened to a stalk by the pincers all its family are provided with. This rotifer is just drawing an amœba into its mouth by the motion made in the water with the fine hairs round its mouth. Both are of course made a great many times larger than life for us to study them closely. It will amuse you to know that after this rotifer had sucked in this amœba it changed its mind about eating it and sent it out of its mouth again. The amœba swam away as if nothing had happened.

All the rotifers are covered with a smooth hard skin; their bodies are divided into six parts; and most of them have true stomachs and intestines, with an anus and a nervous system. It is, however, what is called their water vascular system, and certain of their habits, which place them higher up our ladder than any of the creatures you have yet learnt about. A vascular system means a collection of vessels, and a water vascular system is of course a collection of vessels holding water. These vessels

are at the lower end of the body of the rotifer, and have a single opening leading into a kind of bag from which spring two pipes which divide soon after leaving the bag into several branches.

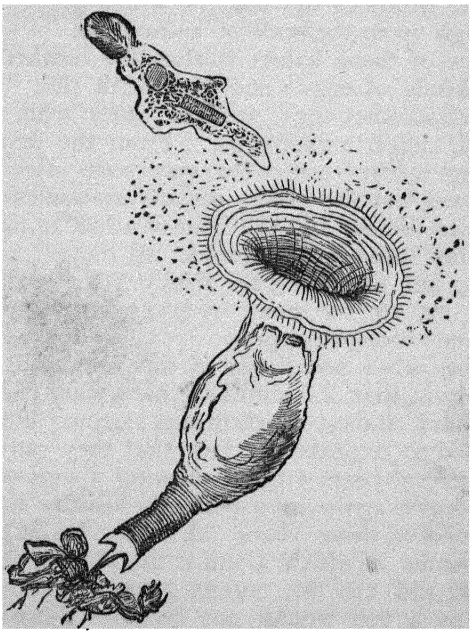


Fig. 26.—Rotifer and Amœba, both greatly magnified.

These branches run all over the body and end near the mouth, so that water can run in and out of the whole of the body. The only other creatures having anything at all like these wonderful

water passages are several parasites or animals living on and in other animals. About the parasites you will read in my book called "Simple Air Breathers" Now I must tell you of the habits of the rotifers, which place them so high up in the scale of animal life.

One of these habits is that the mothers lay two kinds of eggs; one kind with thin shells, called summer-eggs, and the other with thick skins, called winter-eggs. From the first the young rotifers come out very soon after they are laid, but the others remain motionless and appear lifeless till the cold weather is passed. By this means is prevented all danger of the dying out of the rotifer family. No creatures, you see, are too small or lowly for their great Maker's thoughtful care.

The other peculiarity of this wonderful little family is that its members have what is called dormant vitality, which means sleeping life, and is used to express the fact that they can sleep for several years without showing a sign of life, and wake again in a perfectly healthy state at the end of those years. A rotifer, taken out of the water in which alone it can do the work of living and use the organs given to it, does not die as a fish would, but becomes dormant or sleepy. As soon as it is put back in the water it opens out its water passages, sends forth its hairs or cilia, the water flows into its vascular system, the creatures it lives on are drawn into its mouths with its wheels, and all is the same with it as if its dry and silent state had never

been. As we climb higher and higher up our glorious ladder I shall often have to speak of dormant vitality; but the only water creatures without backbones which share this power with the rotifers are a small group of mollusca, the Pond-snails, which can be frozen quite hard without dying, of which you can read in my book called "Lowly Mantle and Armour-wearers."

To-day we have learnt:—1. The rotifers, or wheel-animals, are so called because the threads about their mouths make a motion in the water resembling a wheel. 2. The rotifers, though most of them invisible to the naked eye, are more highly organized than the Polyzoa, Actinozoa, Hydrozoa, or Protozoa. 3. They exist all over the world, in fresh and salt water, hot and cold climates. 4. The rotifers are each covered with a smooth hard skin, their bodies are divided into six parts, and most of them have true stomachs, intestines with an anus, and a nervous system. 5. What places them so high in the scale of animal life is their water vascular system or collection of vessels through which water flows in and out of their bodies. 6. These vessels are at the lower end of the body and have a single opening leading into a bag from which spring two pipes which, soon after leaving the bag, divide into several parts and run all over the body, ending near the mouth. 7. The mother rotifers lay two kinds of eggs, one with thin shells, called summer-eggs, and the other with thick skins, called winter-eggs. 8. From the first kind young ones

are born very soon after they are laid, whilst the others remain unhatched throughout the winter. 9. The rotifers possess dormant vitality, that is to say they can sleep for several years without taking food.

We have now taken one hundred and twenty steps up the ladder of the knowledge of animal life, yet we have but crossed the threshold of the great kingdom to which the creatures we have read of belong. The story of animal life is taken up where we lay it down here in another little book, "Lowly Mantle and Armour-wearers," and the first step taken with its help counts as one hundred and twenty-one in our long and glorious climb.

QUESTIONS FOR EXAMINATION ON "LOWEST FORMS OF WATER ANIMALS."

WHAT are the chief differences between animals and plants? What is an organ? What does organic mean? What is the chief difference between an organic and an inorganic body? Describe the result of death on an organic body? What is protoplasm? What does the word protoplasm mean? Into what two great parts is the animal kingdom divided? Of what are all organic bodies made up? What is the chief difference between the cells of an animal and those of a plant? What are the names of the chief divisions of the lowest forms of animals? Give the meaning of each of these names. What organs has a rotifer which a hydra has not? What does amœba mean? To what family do the sponges belong? Describe the growth of a sponge from an egg? What is a stomach? What is an intestine? What is an anus? What is digestion? What are the chief peculiarities of the rotifers? What is dormant vitality? Give an instance of dormant vitality from amongst the lowest forms of water animals. In what does the volvox resemble the amœba? How does a hydra numb its prey? How do sea-anemones feed?

How are medusas born into the world? Where are the eyes of a medusa situated? Describe the growth of a coral island? Is coral formed inside or outside of the coral-maker? Do the polyzoa lead separate lives?

GEORGE PHILIP AND SON, PRINTERS, LIVERPOOL.

PART II.

LOWLY
MANTLE & ARMOUR-WEARERS.

CONTENTS.

ILLUSTRATIONS.

LOWLY MANTLE AND ARMOUR-WEARERS.

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LESSON I.[1]

WHAT INSTINCT IS

IN my little book called "Lowest Forms of Water Animals," I have introduced you to one or two members of each of the four lowest families of Animals. We will now make acquaintance together with three groups or sets of animals which I shall call mantle and armour-wearers, because, however unlike they are in other things, they all protect their soft bodies with a thick skin, sometimes like a mantle and sometimes like a suit of armour.

You have read in that same little book that an animal is a living, growing creature, with the power of bringing into life other living, growing creatures like itself. I have told you, too, that every part of every animal is made up of what are called cells, and I have given you a picture of a group of animal cells. In case you have not read that book, I will have a copy of this

[1] Every child using this book should be provided with a dictionary, and look for every word he or she does not understand.

picture put in here. Remember that it shews you what any tiny bit of any part of any animal would look like, if it were made very much larger than it really is, and that the name given to a number of such cells is protoplasm.

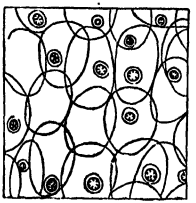


Fig. 1.—Group of Animal cells forming Protoplasm, greatly magnified.

There are two or three other facts that I taught you in my first Reader on Animals which I will repeat here, to make quite sure that the ground from which this new "Ladder" starts is firm enough to bear its weight.

First remember, then, that when I say "seen with the naked eye," I mean looked at without the help of glasses; and when I speak of the microscope, I mean an instrument fitted up with glasses, such as have the power of making things seen through them look much larger. Many of the facts we shall learn in this book could not have been found out without the help of the microscope.

Do not forget, either, that the Animal Kingdom is divided into two great parts—one including all creatures with, and the other those without, backbones. None of the lowly mantle and armour-wearers have backbones, so we shall not yet learn what that name means.

Remember, too, that the different parts of which animals are made up are called ORGANS, and that the first meaning of the word organ is an instrument or tool. The organs of animals

are in fact the tools with which they do the work of breathing, growing, feeding, and moving about.

The lowest forms of water-animals, as you have already learnt, have very simple organs, and they use the same tools for very different tasks. You will remember that the hydra can be cut to pieces or turned inside out without doing it any harm, but that if you cut a sea-anemone in half you will kill it. The reason of this difference is, that any part of a hydra will do for a stomach, or tool to turn food into new flesh; but that the sea-anemone, a creature higher up our Ladder than the hydra, has a stomach or separate tool for the work of turning food into new flesh. The higher the animal is, the more tools or organs it has, and the more difficult it is for the owner of the tools to do without them if they are hurt. If you understand this you will expect me to tell you, as we climb each step together, of new organs used by the creatures we read of; and you will not be disappointed. Not only shall I tell you of new organs, but I shall have to explain that these new organs are divided into many different parts, each part fitted only to do a little of the work of the organ it belongs to.

We see something of the same kind of thing in the world of men and women. Savages, or wild men, use the same set of tools for everything; they kill and cook their own food, build their own huts, and make for themselves the few clothes they care to wear. We, the children of a higher race, divide all this work amongst us: one man

becomes a bootmaker, another is a tailor, another a baker, and so on and so on. We shall find our mantle and armour-wearers using wonderful organs for making their clothes and homes, and some of them resemble us human creatures in the best of all the powers we have; for they not only know how to take care of themselves, but, as we shall see, they shew thought and care for their little ones.

There is a word I shall often have to use in this little book, which I should like you to learn and remember. It is INSTINCT: the name given to the power lowly creatures have of working out their Maker's will, without knowing they are doing so. When I say an animal does anything by instinct, I mean, that in so acting it is obeying the voice of God, which speaks to it in language it can understand.

In this the first part of the second stage of our long journey, I have only taught you two new facts. They are:—The higher an animal is, the more organs it has; the power which enables an animal to do the Will of God, without knowing that it is doing it, is called Instinct.

LESSON II.

LAMP-SHELL-MAKERS, AND OTHER ARM-FOOTED MANTLE-WEARERS.

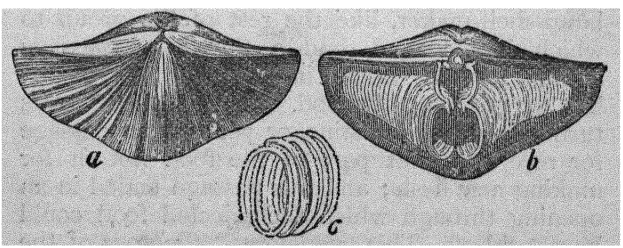
The family name of the Lowly Mantle-wearers is MOLLUSCA, a word which means soft; and all the creatures belonging to this family have soft, cold, sticky flesh, protected by a thick skin called

the mantle. This skin quite covers the body of its owner, and is very elastic; I mean it can be stretched out or drawn in. In the common slug you can see this mantle very clearly.

Most of the Mollusca have shells to protect them as well as mantles. These shells are deposited or produced by the mantle, and are of very beautiful shapes and colors. The Mollusca family is divided into a great number of groups or sets, and each group has a hard name with a very simple meaning wrapped up in it. You must try to learn these names for the sake of their meaning; but if you cannot remember both, please do not forget the meaning, because that is the really important part.

We know now that all the Mollusca have soft bodies protected by mantles, and that from most of these mantles grow shells. Let us now take each group, and learn its name, with the meaning wrapped up in it.

Group No. 1 is called BRACHIOPODA, a name which means arm-footed. As you will guess, all



Figs. 2, 3, *and* 4.—LAMP-SHELLS MADE BY ONE OF THE BRACHIOPODA GROUP.

the creatures belonging to this group have arms and a foot. They live far down at the bottom of the sea, and I have not been able to get a portrait for you of a living one. All I can show you are the empty shells of one long since dead, called the lamp-shell-maker. When the creature that made these shells was alive, it generally kept the shells shut together, and its long arms drawn in. I want you to look closely at the right-hand shell marked *b*. The threads coiled up or wound round and round like ropes were once the living arms, and from the part of the shell marked *d* grew the thick stalk called the foot. The little picture marked *c* shews you one arm, which was just beginning to untwist when death stopped the movements of its owner for ever.

Every mark you see on these shells is a copy of the mantle from which and with which they grew. Within the mantle all the soft parts of its maker were kept safe and warm, so that the work of digestion, or the turning of food into new flesh, could be done without interruption. Now let us learn what these soft parts were. This lamp-shell-maker, like the rest of the group to which it belonged, had a throat, or passage leading from its mouth into its stomach, or the bag for receiving its food. This stomach in its turn led into an intestine, or yet another passage for receiving that part of the food not fit for making new flesh; and this passage ended in an opening through which the rejected food could be got rid of. This opening was the anus of the lamp-shell-maker.

I have already told you, in my little book called "Lowest Forms of Water Animals," of other creatures each with a stomach, intestine, and anus; but our lamp-shell-maker, like all its brothers and sisters, had yet another organ forming part of its stomach, which I have never before spoken to you about. This organ was a LIVER; that is to say, a vessel in which anything that is impure in the food swallowed by its owner, is separated from that food before it can do any harm to the rest of the body.

Behind the stomach of our lamp-shell-maker was a little vessel, much smaller at the upper than the lower end. This little vessel did the work of a heart for its owner; that is to say, it received all its white blood, and sent it forth on its work of nourishing or feeding the body. Not only had our friend, when it was alive, a liver and something of a heart, it had also a nervous system; that is to say, a set of thread-like organs of feeling, beginning behind its mouth, and from thence spreading into every part of its body.

The lamp-shell-maker was, then, a creature of very much higher organization than any of the Lowest Forms of Water Animals; and besides all these inside beauties he had the power of making out of the food he swallowed the beautiful shells you see in my picture. No one can tell exactly how he produced those shells, but we know they are made of lime, a substance contained in the sea-water in which he lived. This lime, after being swallowed, was, so to speak, pressed through the mantle of the lamp-shell-

maker, and first appeared as tiny hard grains in a very thin soft skin. This thin skin gradually grew harder and thicker, till it was firm enough to be called a shell; and above this first skin grew another, forming in its turn the next layer of the shell. You must try and watch some land mollusc actually making its home. That will teach you better how all shells are made than pages of description can.

I wonder if you noticed that I said nothing in my first little book about the breathing organs of animals, although I told you that all animals breathe. I was silent because none of the Protozoa, Hydrozoa, Actinozoa, Polyzoa, or Rotifera have separate organs for breathing. It is different with the mantle-wearers, and I think the most wonderful thing about them, next to their power of making lovely shells, is the way they breathe. Their great Creator has given to each group breathing organs exactly suited to the places in which they have to live, so that whether their homes are in the deep sea, near the shore, or on the dry land, they can take in and send out the air they need without any difficulty.

Let us see how the maker of such lamp-shells as those in our picture breathes. We will imagine ourselves able to breathe in the water as it can, and settle ourselves near its home to watch its actions.

Its foot is firmly planted on some rock, its shells are half open, so is its mouth, with the edges of its mantle looking like lips curled a little back. Its long arms, springing from each side of

its half open mouth, are unwound and splashing the water about. Look closely at these arms, and you will see that they end in a number of fine thread-like hairs, forming a kind of fringe. These hairs make a current, or flowing to and fro, of the water, and help the lamp-shell maker to catch its food by drawing it towards its mouth; and they also bring with the water the air which it needs as much as food. Now we want to find out how this air is sucked into the body, for it does not go with the food into the mouth. To discover this secret we must look closely at the mantle, and we shall then see that it is crossed and re-crossed all over with tiny vessels or passages, through which flows the white liquid called the blood of the mantle-wearer. These little vessels all end in very fine hairs, which are always quivering and trembling. IT IS THIS QUIVERING AND TREMBLING WHICH DRAWS THE AIR FROM THE WATER AS IT WASHES OVER THE SHELLS AND MANTLES. In other words, the lamp-shell maker breathes with the help of the fringe of hairs in which the blood-vessels of the mantle end.

Now let us count up the facts we have learnt to-day.—1. The family name of the Lowly Mantle-wearers is Mollusca. 2. Mollusca means soft, and all the creatures of the Mollusca family have soft, cold, sticky flesh. 3. All the Mollusca have thick skins, called mantles, covering their soft bodies. 4. From and with the mantles of most of the Mollusca grow shells. 5. The Mollusca family is divided into a great many groups or

sets, the lowest of which is called the Brachiopoda. 6. Brachiopoda means arm-footed—and all the creatures of this group have one firm stalk called a foot, and two long arms. 7. What places the Brachiopoda higher than the Protozoa is, that they each have a liver, and a small vessel resembling a heart. 8. A liver is an organ in the stomach for separating any impurity from the food swallowed by its owner. 9. A heart is a vessel from which the blood is sent forth on its work of nourishing the body. 10. The Brachiopoda have all well-organized nervous systems. 11. The shells of the Mollusca are made of lime, which is first swallowed, and then pressed through the mantle. 12. The Mollusca have all special organs for breathing—a peculiarity not shared by any creatures lower than they in the scale of animal life. 13. The Brachiopoda breathe with the help of fringes of hairs, in which their blood-vessels end. 14. These fringes draw the air from the water, as it washes over the shells and mantles of the arm-footed creatures.

LESSON III.

SOME TWO-LEAVED SHELL-MAKERS AND GILL-BREATHERS.

Next above the Brachiopoda in the great Mollusca family, is a group with a name even longer and harder than it. This name is LAMELLIBRANCHIATA, and the group includes the animals commonly called oysters, mussels, scallops, and cockles.

The word Lamellibranchiata means with plates and gills, and all the creatures belonging to this group make what are called bivalve shells, and breathe through organs called gills. Bivalve means with two folds or plates—so you see the peculiarities of this group are, so to speak, wrapped up in its name.

The fact that oysters, mussels, scallops, and cockles breathe through well-organized gills, places them much higher than any creatures we have yet learnt about together. The lamp-shell-makers and their cousins, as we know, have organs resembling gills, but they are not nearly so perfect as the breathing-tools of our new friends. A gill is the simplest form of special breathing organ, and such organs are of many different kinds—each suiting the needs of the creatures to which it is given. Those of the mussels, scallops, and whelks are plates of thin white skin called membrane, with thread-like veins or passages running all over them. Through these veins flows the white blood of their owner, and air is sucked through the thin plates of membrane as the water flows over them. The gills are fastened to the inner side of the mantle, which the oysters, mussels, cockles, and scallops share with the rest of the Mollusca, and look like delicate transparent frills. Here is a picture of the inside of a mus-

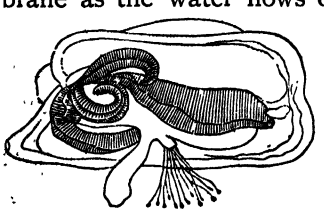


Fig. 5.

sel, shewing its gills, and the fringe of hairs in which they end.

The mouth, throat, stomach, intestine, and anus of the Lamellibranchiata resemble those of the Brachiopoda; but instead of the simple little vessel which serves the latter as a heart, oysters and their cousins have an organ with two chambers or divisions, through both of which the white blood flows on its way to nourish the body. The nervous system, too, of the plate-making gill-breathers, is a much grander one than that of the lamp-shell makers. Every oyster, mussel, scallop, and cockle has three sets of nerves. One of these sets, that starting from either side of the mouth, does some of the work of the brain of higher animals; that is to say, with it its owner *thinks*, and from it are sent orders to the rest of the body, telling it what the oyster, mussel, scallop, or cockle wishes that body to do.

On the edge of the mantles of most of the creatures belonging to the group you are now learning about, there are some tiny red spots supposed to be eyes; and many naturalists think that these little animals can also hear and smell, so that they seem to be gifted with quite a number of new powers.

I do not think I need describe the appearance of an oyster to any English children. You are all familiar enough both with the appearance of its dead body and of its shells; I will only add that when their owner is alive these shells are fastened to some rock at the lower end, and the dweller in them keeps them half open, quietly

waiting for food to be washed into his mouth. Any of you, too, who have been to the sea-side will certainly have seen mussels clinging firmly to the wood of breakwaters, or clustering about the piles of piers. If you have ever tried to drag a mussel from its resting place, you will have found that it was holding by a great number of threads, which it was almost impossible to loosen without a knife. These threads are made by what is called the foot of the mussel, which is a strong flap or piece of loose flesh growing from below the body, and made up of a number of layers or rows, laid one on top of the other, of what is called MUSCLE. A muscle is an organ of motion, made up of a bunch of fibres or thread, protected by a thin but firm skin. This collection of muscles is the only organ of motion possessed by mussels, and they only use it now and then to move about with. When they are taken by force from one place, for instance, they hop about with this flapping foot till they find another suitable home, when they at once bind themselves to this new home by squeezing a milky juice out of their foot, which juice hardens into a thread when it comes into the air.

The scallop also binds himself to his home with a juice which turns to threads, but he is not so lazy as his cousin the mussel, and often draws up his foot to go rolling about in the waves on a frolic, the eyes at the edges of his mantle shining brightly as they are touched by the sunbeams.

The cockle is even more of a wanderer than the scallop, and uses his long foot to leap about

with and burrow in the sand, bending this foot under him when he is going to jump, but stretching it out when he wants to dig a hole.

One and all of our new friends make themselves shell houses to carry wherever they go, by the same wonderful means that I described in our last lesson—that is to say, pressing the lime they have swallowed through their mantle, and using the mantle, so to speak, as a pattern for the shape of the shells.

If you have never seen living oysters, scallops, or cockles, you can certainly get some friendly seller of fish to show you them dead in their shells, for they are all used for food. I shall not, therefore, give you a picture of any of them, but I choose as an example of a two-leaved shell-maker and gill-breather, the wonderful ship-worm, so called because of the mischief it does to vessels by boring into their wood-work. My picture shows you the two-valved shell growing from the mantle, and part of the soft body of the "borer" when actually at its mischievous work.

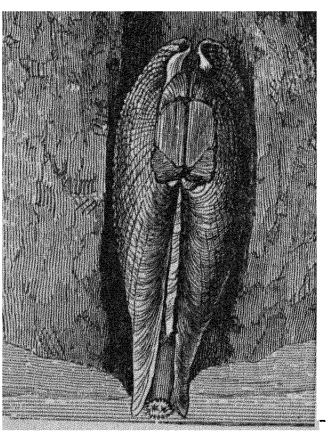


Fig. 6.—SHIP WORM BORING INTO ROCK (*natural size*).

It is only quite lately that naturalists have discovered that it is with the soft body, helped by the sharp edges of its shell, that the ship-worm hollows out regular grooves in the hardest substances. If you have any sailor friend, ask him to tell you more about these wonderful workers, and, if he can, to show you a bit of wood they have spoiled. The ship-worms give a great deal of the same kind of light as the Infusoria and Medusas. Fishermen sometimes eat them raw, and when they do so their lips shine in the dark as if they were on fire. Perhaps some day you may get a living ship-worm with its piece of wood. If you do you will find it very interesting to watch its earnest industry.

All the Lamellibranchiata are born from eggs; an oyster sometimes lays as many as two million in a year, and baby oysters, scallops, mussels, cockles, &c., swim about naked, looking like tiny round hairy balls, till they find a suitable resting-place, when they begin to make their shells, throw out their threads, and so on.

This has been a long lesson, yet I have only told you a very little about a few members of one group of the great Mollusca family. I hope that little has made you eager to learn more, and that you will never lose an opportunity of watching for yourselves the ways of the creatures which I can only introduce to you.

The chief facts we have learnt to-day are:—1. The group of Mollusca above the Brachiopoda is called Lamellibranchiata. 2. This name means with plates and gills, and all the creatures be-

longing to the group make bivalve shells, and breathe through gills. 3. Bivalve means two-leaved. 4. A gill is the lowest form of breathing organ, and there are many different kinds of gills. 5. The chief members of the Lamelli-branchiata are oysters, mussels, scallops, and cockles. 6. The gills of these creatures are plates of thin white skin called membrane, with thread-like veins running all over them. 7. Through these veins flows the white blood of the gill-breathers, and air is sucked through the thin plates of membrane as the water washes over them. 8. The gills of the group noticed in this lesson are all fastened to the inner side of the mantle of the oyster, mussel, scallop, &c. 9. The mouth, throat, stomach, intestine, and anus of the Lamellibranchiata resemble those of the Brachiopoda. 10. The hearts and nervous systems of this new group are more highly organized than those of the Brachiopoda. 11. The heart is divided into two chambers, through both of which the white blood flows. 12. The nervous system is divided into three sets of nerves; one set, that starting from either side of the mouth, acts as a brain, directing the motions, &c. of the animal it belongs to. 13. Most of the members of this group have red spots on the edge of the mantle, supposed to be eyes. 14. Mussels cling to wood, &c. with the aid of strong threads which they make with a flap of muscle called a foot, growing from the lower end of their bodies. 15. The foot is made up of a number of layers of muscle. 16. A muscle is an organ of motion

made up of a bunch of fibres or threads, protected by a thin firm skin. 17. The threads with which mussels fasten themselves to wood, &c. leave the foot in the form of a milky juice, which hardens when the air acts on it. 18. All the Lamellibranchiata are born from eggs—an oyster laying as many as two million in a year.

LESSON IV.

SOME UNIVALVE-SHELL MAKERS OF THE SEA.

Another little step brings us to the great group of soft-bodied mantle-wearers—containing the whelks, sea-slugs, periwinkles, and many similar creatures, each of which breathes with gills, has a foot growing from the lower end of the body, with the help of which it moves about, three sets of nerves, a head with two eyes, a mouth with regular teeth, a heart a little more highly organised than that of any Mollusca you have yet read of, a stomach and intestine, a mantle growing all round the body, and a shell growing from and with the mantle in one piece, or in pieces succeeding each other in regular divisions. None of this new group make bivalves, all their shells are what are called univalves, that is to say, made in one piece.

I am almost afraid to tell you the name of this new group, it is so very long and hard, as indeed it must be to hold in it a description of the chief peculiarities I have told you of. This name is

BRANCHIOGASTEROPODA, and it means gill-breathing—stomach-footed. I give you here a picture of one of the gill-breathing stomach-

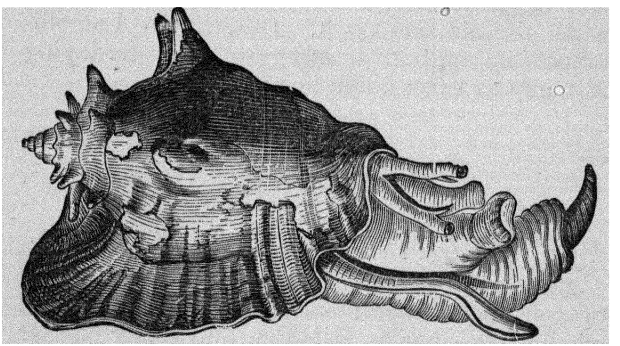


Fig. 7.—STROMBUS GIGAS ANIMAL AND SHELL (*reduced in size*).

footed creatures, as it looks when it is full grown, and has made its shell. It is the Strombus Gigas, which is only found in the waters of the warm oceans near the Equator, and the shell of which is so beautiful that it is used as an ornament in drawing-rooms. The colors as well as the form are very lovely. The creature which makes it is born, like most of the Mollusca family, from an egg, and sets to work to make its shell soon after its birth. The tiny sharp point at the left hand side of my picture is the beginning of that shell, which grows from and with the mantle round and round the soft body of the Strombus.

I shall not give you portraits of any other gill-breathing univalve-shell makers, because you can

easily see most of them for yourselves. Unlike the headless oysters, mussels, and cockles, they creep about the rocks inshore, sometimes even venturing on to the dry land. I will describe one of these mollusca feeding—the periwinkle you so often see lying dead and cold and helpless in the fish-shop windows, or on costermongers' barrows. Our periwinkle does not know he is being watched, so he lifts up his shell, and puts out his little head, with two delicate, quivering horns or feelers, with which he can judge whether all is safe and still. Behind these feelers, and partly protected by them, we see two tiny bright eyes, each at the end of a little stalk ; and if we could see down the inside of these stalks, we should find nerves running from them into the head of the periwinkle. We should want eyes unlike any owned by any living creature to see how it is that these nerves or organs of feeling take to the head and thinking part of our univalve-maker, pictures of all that is seen by the eyes.

Our friend has told himself with the help of feelers and eyes that all is well, and he now ventures to push out a kind of snout, and begins feeding. This snout leads into his mouth, and this mouth is provided with no less than 600 rows of sharp teeth, arranged in threes on a kind of rough strap like a tongue. This tooth-covered strap can be rolled up and packed away in the throat when not in use. We should have to get under the periwinkle, and look up at him from below, to see the actual working of this strap, for his mouth opens from the under side of his head ;

and at the very least alarm the strap is rolled up, the mouth shut, and the body drawn into the shell, which is then quite closed by a wonderful little tough door of horny skin. We will suppose that no such fright has come to our friend, but that his feelers, snout, and teeth are all hard at work, quickly making havoc on the seaweed chosen for his meal. He has eaten all within his reach: he wishes to move on. Now his foot, growing from his stomach, receives a message sent down through the nerves starting from the head; and in obedience to this message it stretches itself out, and, by drawing in and out the muscles of which it is made up, it slowly moves the whole body of the periwinkle along, with the shell on its back. The path of the periwinkle is marked by a track of slime, which comes from a gland or vessel in the foot, and makes the ground smooth and soft for the passage of the creature's tender body when unprotected by its shell.

We will now see where the gills, shared by all the univalve-shell makers, are placed in our periwinkle, and how he takes in and gives out the air necessary for him as for all living creatures. The gills of the periwinkle are fastened on to his mantle, where it is widest and is covered with the largest part of his shell; and, like those of the Lamellibranchiata already described, they end in hairs, which, by always waving to and fro, bring the air to them. When the tide is going down, the periwinkle knows he will be left without the water, which is as necessary to him

as air; and these hairs enable him, when that time comes, to suck in a little stock both of air and water, before he draws in his body and shuts the door of his shell, to wait the return of his true element.

The periwinkles and their cousins are all born from eggs, and the instinct of the mothers leads them to lay these eggs in safe places, and to stick them with a kind of gum, which they have the power of squeezing out of their bodies, to sea-weed, such as is good for food for the baby periwinkles when their soft round bodies first come into life. Try and find a bunch of eggs next time you go to the sea, and keep it in a basin of salt water with the seaweed it is sticking to till the little ones come out. Then watch them roll about in the water, and begin the making of their shells, each of which first appears as a tiny speck on the mantle.

Now what have we learnt to-day?

1. The group of Mollusca next above the Lamellibranchiata is called the Branchiogastero-poda, a word meaning gill-breathing stomach-footed. 2. Every creature belonging to this group breathes through gills, and has a foot growing from the lower end of the body, three sets of nerves, a head with two eyes, a mouth with regular teeth, a heart, a stomach and intestine, a mantle growing all round the body, and a shell in one piece, or in pieces succeeding each other in regular divisions. 3. Shells made in one piece, or in pieces regularly succeeding each other, are called univalves. 4. The Strombus Gigas is a

tropical example of the Branchiogasteropoda. 5. Periwinkles, sea-slugs, whelks, and many other common creatures easy to procure on the English coast, also belong to this group. 6. The periwinkle lives and feeds amongst the rocks and seaweed close inshore. 7. From his head grow two feelers, which he can draw in and out at will, and behind these feelers are two eyes, each set on a short stalk. 8. Within the mouth of the periwinkle, which opens on the lower side of its head, are 600 sets of teeth in rows of three, growing from a kind of strap, which is rolled up and packed away in the throat when not in use. 9. When the periwinkle is frightened, or when the tide is going down and he will be left dry, he draws himself into his shell and shuts down a little door of horny shin, growing from his mantle. 10. The periwinkle moves with the help of the foot growing from the lower end of his body. 11. From this foot, as he draws it in and stretches it out in his slow crawl, he squeezes a kind of slime, to make his path smooth and easy. 12. The gills of the periwinkle grow from the mantle, where it is protected by the largest part of the shell. 13. These gills end in hairs, with which the air needed is drawn to the gills. 14. With these hairs the periwinkle collects a little store of water and air to use whilst it is left dry waiting for the return of the tide. 15. All the Branchiogasteropoda are born from eggs, which are laid by the mothers in safe places, on or near suitable food for their young.

LESSON V.

SOME LOWLY MANTLE-WEARERS OF THE LAND.

Our next step takes us, for the first time since we started on our climb together, away from the sea to the haunts of the Land-Mollusca, the snails and slugs we all know so well, called the PULMOGASTEROPODA, a word meaning lung-breathing stomach-footed.

This name is a sign that we have now to speak of a new breathing organ, a LUNG, the name given to an air-bag inside the body of every creature living on the land. The first meaning of the word lung is light, and it is used in speaking of the air-bag, or, as it is usually called, air-sac, because it is of a light substance. In animals with backbones the lungs are of very complex form; that is to say, they are divided into many parts; but in snails and slugs the lung is very simple. The lung of the land-snail consists of a fold in the mantle behind the neck, forming a kind of compact box, with a slit in the neck which opens and shuts constantly, taking in and letting out air. The inside walls and the floor of the lung are covered with fine vessels, forming a perfect network, through which the white blood flows. This blood is brought from all parts of the body to the air-chamber, to be purified with fresh air, through two large veins, and it flows back again to the heart through one still larger vein. The heart consists of a single chamber.

The lung of the slug is also situated just behind the neck, under the mantle, which is here covered

with a tiny shell, the rest of the body being naked but for the mantle. The hole giving access to the lung of the slug is at the left hand side, instead of at the top of the body. As in the snail, the life-giving air is taken, with the white blood, to and from the whole body, through veins leading from and to the heart.

With the exception of the change just described in the breathing organs of the Land-Mollusca, they resemble in their structure, or the way their organs are put together, their stomach-footed cousins of the sea. Their habits, however, are of course different, to suit the very different element in which they live. The land-snail does not often venture forth in broad day-light, for in spite of the protection of its shell, it is an easy prey to many enemies,—birds, hedgehogs, moles, and some large insects considering it a very dainty morsel. As the evening shadows begin to fall, however, the snail ventures to put forth his head, with the long moveable horns, at the end of which his eyes are so placed that he can see all round him without turning his head. These horns are hollow, and when not in use the eyes are turned back in them with the help of a muscle which draws them down. Beneath the horns are two little feelers, the exact use of which is not known, though they are, as their name implies, supposed to be organs of feeling. The land-snail has no such horny door as his cousin the periwinkle; but when he wishes to be undisturbed in his shell, he supplies the place of this door by pouring out from his body a kind of slime, which the air soon hardens.

Many snails sleep all through the winter, kept warm and snug in their shells closed with this hardened slime. They hide themselves for their long motionless time in old walls, or under the bark of trees, where they are not likely to be disturbed. In my picture of a common land-snail, you see him starting forth on his quest for food, ready to devour all the tender vegetables that he can find. Woe to him if a gardener spies him! His doom is sealed, for he and his cousin the slug do more mischief amongst low-growing plants than any other creatures. Snails are born from eggs, which the mothers hide in groups of about a dozen just under the surface of the ground, whence the little ones can easily reach the food they need. Suppose you try and find a bunch of snail's eggs, and watch the first beginning of the tiny life of each snail, with the growth of its shell from the first wee bit of lime it squeezes through its new born mantle.

In a slug, with its small shell hidden away behind its neck and under its mantle, you can see more easily than in the snail the beautiful markings of the mantle, and note how wonderfully elastic it is, its owner being able to stretch it out or draw it in at an instant's notice. If snails are dangerous to the beauties of the garden, slugs are still more so; for each has thousands of teeth, with which he bites away the tender green leaves, and gloats on the strawberries just as they are ripening. Every mother, too, lays many bunches of eggs, hiding them away as cleverly as the snail, in the roots of plants, in old walls, or in the rotten

bark of fallen trees. Side by side with your bunch of snail's eggs, suppose you watch a few laid by some mother slug. This will help you to see the difference in their mode of growth better than any picture can, though for the sake of children living in the heart of some great city, away from even a garden, I give you with my picture of the snail portraits of two kinds of slugs. The one on the right hand side crawling up the leaf is the great grey slug, and the one clinging to the tree trunk is a smaller kind called the Testacella. In the left hand corner of the picture is a little

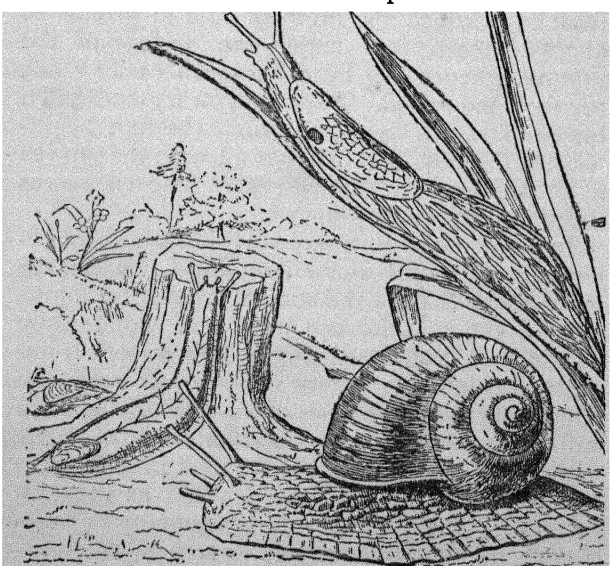


Fig. 8.—A LAND SNAIL, A GREAT GREY SLUG, AND TWO SMALL SLUGS CALLED TESTACELLAS.

Testacella burying itself in the ground. You can see the breathing hole of the great grey slug quite clearly, and in each of the three slugs the shell is plainly marked.

To-day we have taken one great step, for we have for the first time spoken of a lung. Our facts gained are: 1. The group next above the gill-breathing stomach-footed mollusca is called Pulmogasteropoda, a word meaning lung-breathing stomach-footed. 2. A lung is the name given to the breathing organ of any creature living on land. 3. The first meaning of the word lung is light, and lungs are always of a light substance. 4. The lungs of creatures with backbones are divided into many different parts. 5. The lung of the snail and of the slug is a simple organ, consisting of one part only. 6. The lung of the snail consists of a fold in the mantle behind the neck, forming a compact box, with a slit in the neck, constantly opening and shutting. 7. The walls of this lung are covered with fine vessels, through which flows white blood. 8. This white blood flows to the air-chamber through two large veins leading from the heart, and back again when purified with fresh air through one large vein leading to the heart, which consists of a single chamber. 9. The lung of the slug is behind the neck, under the mantle, just where the tiny shell covers it. 10. The opening of the lung of the slug is on the left hand side. 11. Except with regard to their breathing organs, the Land Mollusca resemble those of the water in general structure. 12. The land snail generally feeds at

dusk, and makes great havoc in a garden. 13. It is provided with eyes, set on hollow tubes, down which the eyes when not in use are drawn by a muscle. 14. Snails sleep in the winter, shutting up the opening of their shells with hardened slime. 15. Snails are born from eggs, which are hidden by the mothers just under the surface of the ground, or the bark of trees. 16. The slug has its shell hidden under the mantle just over the lung, which it protects from injury. 17. Every slug has thousands of teeth, and does great mischief in a garden. 18. Slugs also are born from eggs, of which the mothers lay great numbers in the roots of plants, old walls, &c.

LESSON VI.

POND SNAILS, SEA-SLUGS, SEA-SNAILS, AND WING-FOOTED MOLLUSCA.

Before we leave the land entirely to return to the ocean, I want to introduce you to the wonderful snails which live in ponds and other fresh waters. I mention them specially because they are the only creatures without backbones which share with the Rotifers (see "Lowest Forms of Water Animals," Lesson X.) the power called Dormant Vitality: that is to say, they can lose consciousness for months or years without dying, if they are placed where it is so cold that their blood is frozen and cannot flow. The name of the pond-snail with this strange power is Lymnæa. The Lymnæa resembles the land-snail in general form, and in the structure of its organs; but, as

its house is in the water, it has gills to breathe with instead of a lung. It grows very very slowly; and one of the results of its dormant vitality is, that if its growth is stopped by cold, and its eggs are laid after it awakes and before it has grown any bigger, the little ones born from those eggs will never grow larger than their mother was when the eggs were laid. The children of this dwarf snail will be dwarfs too, and in time a pigmy race will come into existence.

In such a little book as this, I can only pause now and then to tell of the strange results in the form, or size, or color of animals, brought about by changes in weather, climate, vegetation, &c. But the few facts I CAN tell you are enough to prove to you the beautiful way in which every part of God's creation fits into, and acts upon, every other part.

Now that we have made friends with the garden snails and slugs, and their cousin the Lymnæa, let us return to the sea, and find out if they have any quite near relations there. If our eyes are at all sharp, we shall not have to seek long amongst the rocks inshore without meeting with a creature so like a land-slug, that, but for the rows of standing-up frills growing from his dusky mantle, we might think he had deserted the land for a water garden. This creature is a sea-slug, who began his life in a tiny twisted shell, which he left when he was old enough to take care of himself without it. The rows of frills are his gills, which replace the one lung of the land-slug. Here are portraits of two sea-

slugs—one with his gills in four sets of fringes, the other with the gills collected in a bunch.

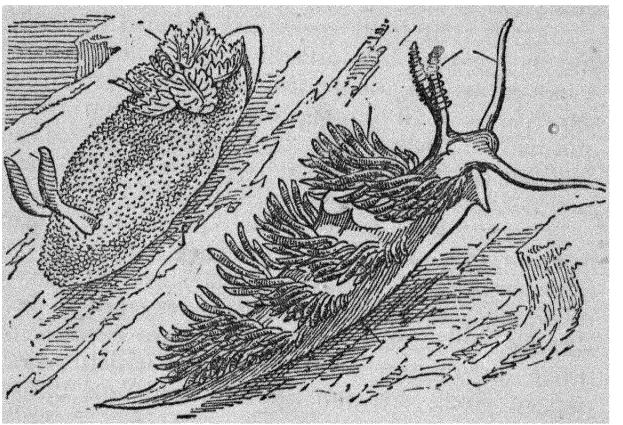


Fig. 9.—SEA-SLUGS.

If we now take a trip in some ocean-bound steamer, and leave the rock-bound coast behind us, we may chance to meet with the lovely sea-snail called the Ianthina, which resembles the land-snail, but actually carries a store of bubbles of air for breathing, on a kind of raft only connected by a single muscle with its head. Beneath this raft, which is about two inches long and half an inch broad, the mother sea-snail carries her eggs, all kept together with the slime which she, like all her family, has the power of producing from her body. Here is a picture of this raft-bearing snail, and beneath it is a portrait of its cousin the Carinaria, which has a foot with which

it swims, and carries its shell protecting its gills upside down.

Leaving the slugs and snails, with their wonderful contrivances for breathing and swimming, we pass to the group next above them, the name of which is PTEROPODA, which means wing-footed, and is given to the creatures belonging to it because their foot is changed into a pair of organs called FINS, with which their owner swims about. A fin is the simplest form of swimming organ, and it is a great step up for a creature to possess fins. As we know, all the animals we have as yet read of swim with

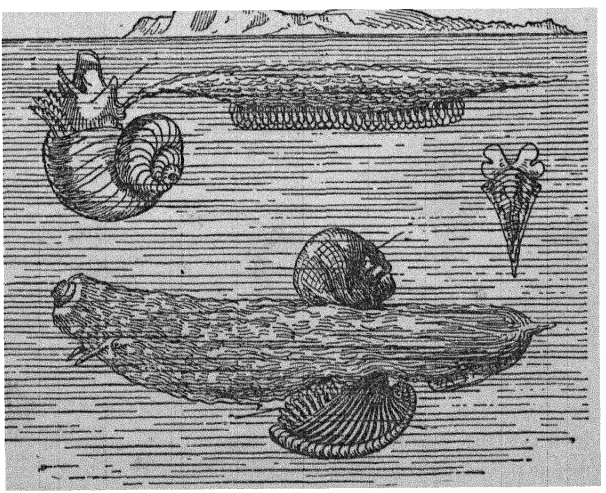


Fig. 10.—SEA-SNAIL WITH RAFT OF AIR-VESSELS AND EGGS, CARINARIA, AND WING-FOOTED SNAIL.

organs used for other purposes as well. The Pteropoda are all very small, and live far out in the ocean, swimming about in such numbers that they give to the waves their own yellowish-blue or violet color. They can fold their delicate fins into their shells at will. These shells are very delicate, and generally of a pale yellow color; they are so transparent that their owners, who have the power of giving light in the dark, sometimes shine through them, as a candle does in a lantern. In the right hand corner of the picture of the Ianthina and the Carinaria is a small wing-footed snail; and I also give you a separate picture of one of the same group called the Cleodora, in which you can clearly see its fins spread out as they look when it is swimming about. Whales and other great sea-creatures swallow the wing-footed mantle-wearers by thousands. It is very difficult to catch them alive, for they die directly they are taken out of the water, and it is only now and then that some great storm casts a few on to the shores of England or America. There is one in the British Museum in London, which was caught alive in a shrimping net a great many years ago, by a gentleman who was fishing near Mull, an island off the west coast of Scotland.

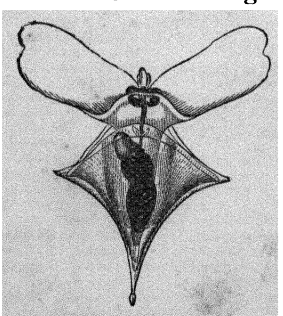


Fig. 11.—CLEODORA. *(natural size.)*

The group of Mollusca next above these lovely little wing-footed creatures is of such great importance, that it will not do to introduce any of its members at the end of a lesson; so we will count up the few steps we have climbed to-day, and reserve the terrible Octopus for a new chapter.

1. A race of pond-snails called the Lymnæa has the power of dormant vitality. 2. Dormant vitality is the power of living through a sleep of months or years. 3. The Lymnæa and the Rotifer are the only creatures without backbones which have this power. 4. If a pond-snail, the growth of which has been stopped, lays eggs before it begins to grow again, its children will be dwarfs. 5. The sea-slug resembles the land-slug in everything, except that it breathes through gills, ending in rows of standing-up frills on its back, instead of through a single lung. 6. The sea-slug begins its life in a tiny shell, which it leaves as it grows older. 7. The sea-snail lives far out in the Ocean, and carries with it a supply of air on a kind of raft, attached to its head by a single muscle. 8. Beneath this raft, which is about half an inch wide and two inches long, are glued the eggs of the sea snail. 9. Above the snail and slug Mollusca comes the group called Pteropoda, or wing-footed Mollusca. 10. These creatures are called wing-footed because their foot grows into two wing-like fins. 11. A fin is a swimming organ. 12. The Pteropoda are all very small, and swim about in great numbers far out at sea, coloring the waves yellow and blue. 13. Their shells

are very delicate, and generally of a yellow color. 14. They can fold their fins into their shells at will. 15. The Pteropoda have the power of giving out light, and this light shines through their shells as a candle does in a lantern.

LESSON VII.

THE OCTOPUS, AND HIS COUSIN THE CUTTLE FISH.

The name of the last and greatest group of the Mollusca family is CEPHALOPOD, a word meaning head-footed. Every creature belonging to this group has a head, and feet or arms arranged round it, so that the name is well given. All the members, too, though they are very different in many things, agree in having the peculiarities I told you in my first Lesson on the soft bodied mantle-weavers, and they have all the three great senses of sight, hearing, and touch. The great difference between the Cephalopoda and the other members of the Mollusca family is, that their one foot sends out from its root a number of feet, or arms, or tentacles, which take different shapes in different creatures. Most of the Cephalopoda, too, have the power of squirting out a black liquid when they are annoyed. I will tell you something about four of the Cephalopoda, each of which is a type of many others like it in all the important organs. To be a type, you know, is to be a representative of others. If you can imagine a land where no boys or girls had ever

been seen, any one of you who went to that land would be a type or representative of all other boys and girls.

The first of my four types or representatives of the Cephalopod family is the great Octopus, a creature whose name means eight-footed; so you know at once that from the one foot it shares with all the Mollusca grow eight arms, tentacles, or feet, whichever you like to call them. Here is a picture of the common Octopus, which will shew you what a terrible-looking creature it is. You see that it makes no shell for itself, though its mantle contains the beginning of a shell, from which a further protection would most likely grow if the Octopus were living where such a protection was needed. It is a wonderful fact that God gives to almost all His creatures the power of suiting themselves to different states of life. When you are older, you must study the effects on vegetable and animal life of changes in light, heat, air, soil,

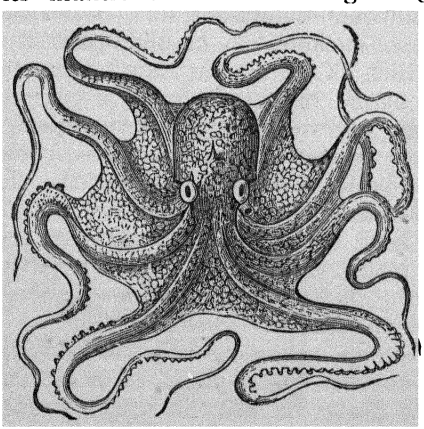


Fig. 12.—COMMON OCTOPUS (*reduced in size*).

and all the countless arrangements made by the Great Father of Life for all His children.

I do not think that with my picture before you I need tell you where the head and eyes of the Octopus are, or describe the great arms springing from its body. What my picture does not shew you is that the great arms are six times as long as the body, and have each 120 suckers or hollow pipes. These suckers are very wonderful organs, and are used by the Octopus as cupping-glasses are by doctors and chemists. If you have any doctor or chemist friend, ask him to shew you a cupping-glass, and let you see him use it. You will then know what an Octopus can do with his 960 suckers. A cupping-glass is a vessel from which all the air has been taken, and which, when placed on the body of a patient, draws the blood into the veins under the vessel.

You can see in my picture how closely the mantle fits the body of the Octopus, but the picture does not clearly shew you how this mantle opens at the neck like a greatcoat; nor can you see the gills, inside the mantle and fastened to the front of the body like the ruffles of a shirt, through which the Octopus breathes.

When an Octopus swims it swells out its body, shuts up its mantle closely round its neck, and then suddenly draws its body in again, so that the water it has swallowed is jerked out, and the great creature is driven suddenly backwards, the long arms trailing out like seaweed which is drawn along by its roots. The water is jerked out through a short funnel or hollow tube, which

sticks out of the neck. The arms are not used in swimming at all, but only for seizing prey. They are so strong, that a man who is caught by them is in danger of serious injury, if not of death by suffocation. A gentleman who was once examining a coral reef on the coast of South America, had a terrible struggle with an Octopus. Whilst looking down into a pool of quiet water, he saw a soft body, with a pair of very bright eyes, packed away amongst the coral, and put his hand down to pick it up. In an instant his hand was seized, and though he tried very hard to get it free, he could not move it at all. The suckers were all busily at work drawing his blood into the veins they covered, and the pain was very sharp. The gentleman knew at once that he was caught by an Octopus, and in less time than it takes me to write this, all the long arms were wound round his hand. In trying to get free, the poor man touched the Octopus with his left hand. The terrible creature then seized that also with one of the long slimy arms; and the poor prisoner was shouting for help, expecting every moment to be dragged down into the water, when his enemy suddenly changed his mind, let go his hold, dropped on to the sand, and, "raising himself on his long slimy arms, stalked away towards the water, making," says his victim, "such a comical figure that in spite of my fright I indulged in a hearty laugh. He looked like a huge and very tipsy spider."

First cousin to the Octopus is the Cuttle Fish or Sepia, of whom I give you a portrait. The

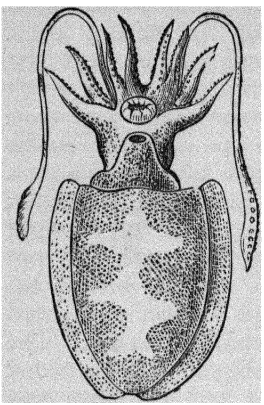


Fig. 13.—CUTTLE FISH *(natural size.)*

Cuttle Fish resembles the Octopus in having a large head, bright prominent eyes, and eight arms with hundreds of suckers; he differs from that cousin in those eight arms being short and broad, in having two extra arms of great thinness and length, ending in two spade-like organs, and in having a long flat body, provided on each side with a fin or wing-like organ such as all fishes have. But the most important of all the peculiarities of the Cuttle Fish is the sort of hard bone in the hollow of its back, which is the beginning of a shell such as all the Mollusca have the power of forming. These bones are often picked up on the beach, after the animals to which they belonged have been devoured by some monster of the deep or have died a natural death. The Cuttle Fish keeps the inky fluid common to most of the head-footed Mollusca in a bag in the lower part of its body.

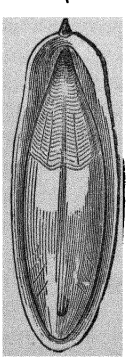


Fig. 14.—BONE OR INTERNAL SHELL OF CUTTLE FISH *(natural size.)*

I must tell you about my other two "types" of the Cephalopod group to-morrow. To-day we have learnt: 1. The last and greatest family of Mollusca is called Cephalopoda, or head-

footed. 2. Every creature in it has a head, with feet or arms arranged round it. 3. The chief difference between the Cephalopods and the other Mollusca is that the one foot which they have in common with their cousins sends out from its root a number of feet, or arms, or ten'acles. 4. The Octopus is the largest and most formidable of the Cephalopods. 5. Octopus means eight-footed. 6. The Octopus has eight arms or feet, springing from its head. 7. It makes no shell, though its mantle contains the beginning of one. 8. Its arms are six times as long as its body, and each has 120 suckers. 9. These suckers act as cupping glasses, that is to say, they draw up the blood of the animals seized by the Octopus. 10. The mantle of the Octopus fits closely; and opens at the neck. 11. The Octopus breathes through gills, fastened inside the mantle on the front of the body. 12. The Octopus swims by swelling out its body and suddenly drawing it in again, so as to send out the water it has swallowed with a jerk. 13. The Cuttle Fish or Sepia differs from the Octopus in having two long arms in addition to the eight round its head, fins or wing-like swimming organs on either side of its body, and a long hard bone in the hollow of its back. 14. This bone is the beginning of a shell, as is the smaller hard substance in the body of the Octopus.

LESSON VIII.

THE SQUID AND THE NAUTILUS.

The third type of the Cephalopod family I have

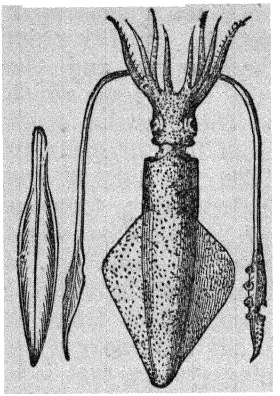


Fig. 15.—CALMAR OR SQUID, AND ITS INTERNAL BONE OR SHELL (*natural size*).

chosen to describe to you is the Squid or Calmar, whose name means an ink-pot, and whose portrait I give you here. This picture will shew you that the Squid is very like the Cuttle Fish, but it is longer in the body, and its internal shell, a little separate picture of which I give you, is thinner, and more like the quill of a feather than a shell.

The Octopus, Cuttle Fish, and Squid are all

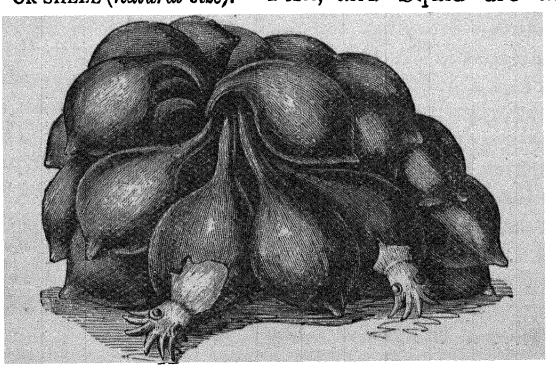


Fig. 16.—EGGS OF THE CUTTLE FISH (*natural size*).

born from eggs, which their mothers lay in the spring, taking great care to fix them to some

seaweed in water warm enough to hatch them. I have often found the eggs of the Cuttle Fish on the beach in Sussex and in Lancashire. If left where the mothers lay them, they take about a month to hatch. Here is a picture of a bunch of the eggs of the Cuttle Fish, with two baby cephalopods just coming out.

My fourth type is a creature of a character and appearance very different from those of the

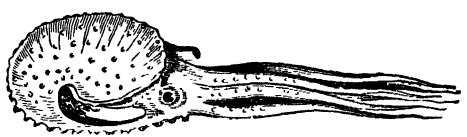


Fig. 17.—ARGONAUT (*natural size*).

fierce Octopus, or the strong and active Cuttle Fish and Squid. It is the Pearly Nautilus, which makes one of the most beautiful of all the many lovely shells of the Mollusca family. I have not been able to get you a picture of a Nautilus, but I give you one of its very near relation, the Argonaut. Its big eye and long arms will shew you that it is also first cousin to the Octopus, though like the Nautilus the Argonaut has no terrible powers of seizing and holding its prey, for its arms have no suckers. It is very difficult to catch a living Nautilus, for these lovely creatures seem to know how eagerly they are sought, and they keep under water, only coming up now and then. Their shells, however, may be seen in many collections, and now and then a living specimen is caught in the warm

oceans of the south. When a Nautilus comes into the world, it makes itself a very thin cell-like chamber to protect its soft body; but when it has outgrown this cell it leaves it, and builds another, and so on and so on till it is full-grown, always living in its last cell. It still, however, keeps up a connection with its old home by a kind of tube of thin skin running through the middle of each cell. Though it generally lives at the bottom of the sea, it can rise to the top when it likes. Some naturalists think it manages to do this by emptying its chambers of air and water, so that its shell becomes light enough to float; and that when it wants to go back it lets in the air and water again, becomes heavy, and sinks. No one, however, knows exactly how this rising and sinking is done. It is one of the things left perhaps for one of you to find out!

I have now given you pictures of, and told you something about, many different members of the great Mollusca family. Do not forget in what they all resemble each other, or in what they differ from each other; and when you go to any sea-side place, or a museum where living animals or their shells are to be seen, try and recognize for yourselves the creatures you have read about here. That will be a great step towards learning to find out to what group a creature new to you belongs.

This is a very short lesson, but I hope we have gained several steps in it. It is something to know that the delicate Nautilus and the great Octopus are cousins; it was a long time before

I could bring myself to believe that. Our few facts won to-day are: 1. The Squid or Calmar is like the Cuttle Fish, but longer in the body, and with a thinner internal shell. 2. The Octopus, Cuttle Fish, and Squid are all born from eggs, which are laid by their mothers in the spring. 3. The Nautilus is a member of the Cephalopod group. 4. It makes a very beautiful and delicate shell, beginning with a very thin cell, which it leaves when it has outgrown it, building a larger one on to it. 5. It always lives in the last cell of its shell, but keeps up a connection with all the others by means of a tube of thin skin running through them all. 6. Though it lives at the bottom of the sea, it can rise to the top. 7. No one yet knows exactly how the rising and sinking is done, but it is supposed to be by the making of the shell heavy or light, according as it is filled with air and water, or emptied of them.

LESSON IX.

THE STAR-FISH AND THE SEA-URCHIN.

We now come to a family of forms much more beautiful than any of the Cephalopods, except perhaps the Nautilus, and a good deal higher up in the scale of Animal Life than any of the Mollusca. This new family is called the ECHINODERMATA, a word which means rough-skinned, and it includes five great groups: the Star-Fishes, Sea-Urchins, Brittle-Stars, Sea-Lilies, and Sea-

Cucumbers. Each of these groups resembles all the others in its members, having true stomachs and intestines, nervous systems, blood circulating or flowing round and round through veins or passages all over their bodies, and a very strong skin covering those bodies. Most of them have also hard plates, made out of the lime they swallow, which strengthen still further this hard skin; and some of them have long strong spines or spikes, springing from the skin, and making a kind of armour.

Another great peculiarity shared by all the members of the five groups of the Echinodermata is that they come into the world in quite a different form to that they will have when they are grown up. Most of them are born from eggs, and come out as soft round bodies covered with the hairs called cilia. With these cilia they swim about for some time, and as they swim the cilia are gradually changed into two bands, from which by degrees grows the body of the perfect animal. When it is nearly full grown it throws away the organs it used as a baby, to make room for the new ones which have grown in their place. When you are at the sea-side you must try and get some fisherman to catch for you a new-born child belonging to one of these rough-skinned water families, and watch its wonderful change from a soft round hairy ball to a beautiful star-fish, sea-urchin, or sea-lily.

I will now take one member as a type of each group, and give you a picture of it in its perfect form. My first picture shews you a Star-Fish or

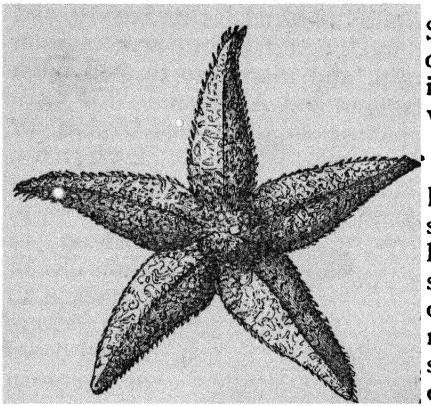


Fig. 18.—SMALL STAR-FISH. *(natural size.)*

Sea-Star, a creature with its body divided as you see into five or more rays like those of a star, and which has under the skin at the tip of each ray a red eye, only seen when danger makes it raise the tip like a lid. This beautiful animal spends most of its life at the bottom of the sea, crawling along on its stomach with the help of what are called its ambulacra or walkers; rows of short fleshy organs, which it pushes out of its soft body through holes in its thick skin. It is a very greedy feeder, and will often eat up quantities of the bait set by fishermen to catch much larger creatures. The children of such a Star-Fish as this are born, like all other Echinodermata, from eggs, and their mother carries them till they are hatched under her body, raising herself up on the points of her rays to make room for them. If you cut off the ray of a Star-Fish it will soon produce another ray in its place; and if you frighten the animal in any way it will throw off ray after ray, and draw itself up into a soft ugly round ball, as if it

knew that it is only admired for its beauty, and not wanted for food. Star-Fishes are common all over the world, and many are thrown upon the shores of England and America.

My second picture is of a Sea-Urchin or Echinus, also called a sea-egg, because it looks like an egg when all its spines are folded down or broken off, as you see they are in the small one near the large one in the picture. This beautiful creature resembles its cousin the Star-Fish in the structure of its body, but differs from it in the arrangement of its protecting plates, and in the wonderful spines with which it is provided. These spines spring from swellings on the hard plates, and are moved by a membrane or thin skin completely covering the plates or shell. Some of the Sea-Urchins use their spines for walking, others bury themselves in the sand with them, and some only use them as armour to protect them; but, whether they use their spines in moving about or not, they all have ambulacra or walkers like those of the Star-Fish, which they push through numerous holes in their shells. They are often

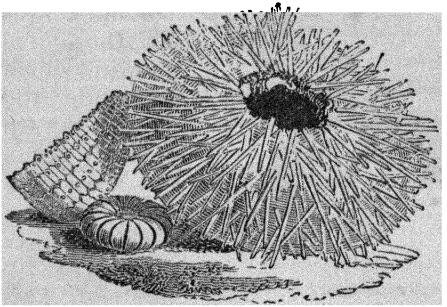


Fig. 19.—SEA-URCHIN *(natural size).*

longer than the spines, and the creatures they belong to can climb the steepest rocks with them. They are hollow tubes, each with a tiny vessel filled with liquid at the lower end. The creature can send the liquid in these vessels up or down the tubes of its walkers at will. When the walkers are full of liquid they swell, and grow strong to adhere or stick to the ground or rock their owner is walking on; when they are empty, they shrink and become useless. They act, in fact, nearly as much like cupping glasses as are the suckers of the Octopus. Is it not wonderful that God should provide suitable organs for the life every creature has to lead?

We must save our other three types of Echinodermata for to-morrow. To-day we have learnt: 1. Next above the Mollusca family is the Echinodermata. 2. This name means rough-skinned, and includes five great groups. 3. These groups are familiarly called the Star-Fishes, Sea-Urchins, Brittle-Stars, Sea-Lilies, and Sea-Cucumbers. 4. All these groups resemble each other in having true stomachs and intestines, blood circulating or going round and round in veins all over their bodies, and a very strong skin. 5. Most Echinodermata also strengthen their skins with hard plates, and some add still further to their defences with spines. 6. All the members of this family are born in a form quite different to that of their parents. 7. Most of them come from eggs, as round soft bodies covered with cilia or hairs. 8. These cilia are generally changed into bands,

from which grows the body of the perfect animal. 9. When any member of this family is full grown, it throws away the organs it used as a baby. 10. The Star-Fish or Sea-Star has a body divided into five or more rays, with an eye under the skin at the tip of each ray. 11. The mother hatches her eggs under her body, raising herself on the tips of her rays. 12. If one ray of a Star-Fish is cut off, another will grow in its place. 13. The Echinus or Sea-Urchin resembles the Star-Fish in its internal organs, but arranges its outside plates differently. 14. It protects itself with an immense number of spines. 15. The Star-Fish and Sea-Urchin are both provided with ambulacra or walkers, which they push through holes in their skin, and which act as the suckers of the Octopus. 16. These ambulacra are hollow tubes, and resemble cupping glasses in their work.

LESSON X.

THE BRITTLE-STAR, SEA-LILY, AND SEA-CUCUMBER.

To-day you are to see the portraits and read of the lives of three more of the great family of hard-skinned water creatures. The first shall be a Brittle-Star, whose name will tell you at once that it is a creature easily broken. It and all its brothers and sisters indeed are made of such very delicate materials that they fling themselves to pieces at a touch, and the slightest squeeze is

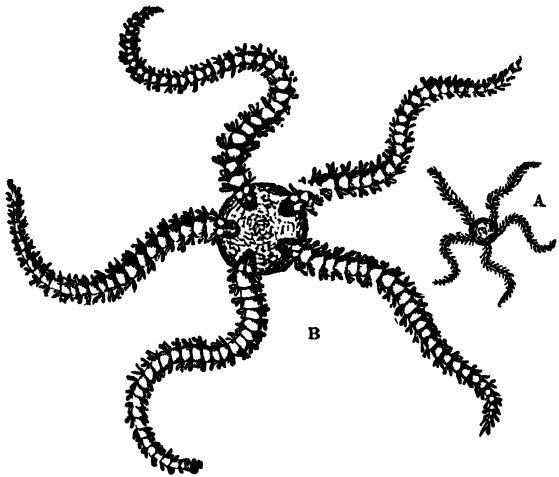


Fig. 20.—BRITTLE STAR—A (*natural size*), B (*magnified*).

enough to kill one, making its body a soft shapeless mass. It seems difficult to believe that a creature so easily destroyed can really have all the organs I counted up when I told you the peculiarities shared by his whole family; yet it is true, and our Brittle-Star, if not meddled with, will swim about for years, eat up a number of creatures harder than itself, and bring up a large family of children as touchy as their parent. The long arms you see in this picture are the chief peculiarity which distinguished the Brittle-Stars from their cousins. These arms are provided with fringes, with the help of which their owner moves and catches his prey. When swimming about, a Brittle-Star looks like a group of

snakes, and fishermen sometimes call these creatures "Serpents' Tails."

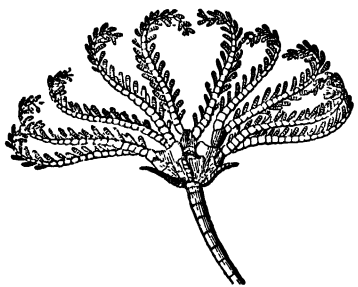


Fig. 21.—ONE "FLOWER" FROM A GROUP OF SEA-LILIES (*magnified*).

My next picture is of a Sea-Lily, which looks more like a plant than an animal, yet possesses all the internal organs common to the Echinodermata family, though it has no spines. The Sea-Lilies lead a very strange and changeable life. They are born from eggs, which fall upon the stones at the bottom of the ocean from the mother lily, as the seeds of so many plants do on the ground. From these eggs spring baby sea-lilies, which begin their lives by fixing themselves to the sea-bottom, or to the body of a full grown lily. In the first case they send a root down into the ground; in the second case they grow like a branch on the old lily for some time. When they are old enough, they break themselves free from their stems, and start off on their travels, spending the rest of their lives swimming or creeping about at the bottom of the ocean. My picture shews you a single flower from a group of Sea-Lilies.

The last portrait I am able to give you from the great Echinodermata family is of one of the Sea-Cucumbers, which, as you can see at a glance,

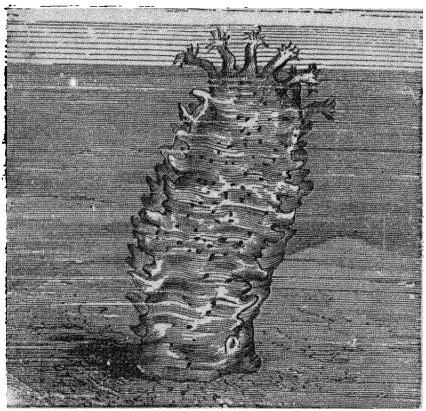


Fig. 22.—SEA-CUCUMBER (*natural size*).

is again very different in appearance to all its cousins, though it has every one of the organs of which I have so often reminded you. This long sea-creature has neither plates of lime nor spines to protect it, such as those of the Star-Fishes or Sea-Urchins; but its skin is very tough and leathery, though the slightest touch irritates it, and it can swell it out or draw it in at will. When a Sea-Cucumber first comes into the world it is round and soft, and swims quickly about with the help of strong muscles in its skin, which it swells out and draws in as it rolls along. Later in life the Sea-Cucumber grows lazy, and only moves now and then in a slow gliding way to get the food it wants.

One of the most wonderful things about the group to which the Sea-Cucumbers belong is that, if its members cannot get enough to eat, they break off parts of their bodies, so as to have less to feed; and if one is attacked it throws away its organs for the time of danger, growing new ones when that danger is over. A great naturalist once kept a Sea-Cucumber in a glass case, and gave it no food for a long time. By degrees it threw away the whole of its body except the top part of its tube, which lived on quite contentedly. I am glad to say its keeper gave it more food after all these sacrifices, and by degrees its body grew again. It would be a great comfort to be able to do without one's body when it is difficult to get food or clothes for it, would it not?

We have learnt to-day: 1. The Brittle-Star is made of such delicate materials that it flings itself to pieces at a touch, and a slight squeeze kills it. 2. The long arms of the Brittle-Stars have fringes, with which their owners swim and catch their prey. 3. Brittle-Stars are sometimes called Serpents' Tails. 4. Sea-Lilies are born from eggs, and begin life on the stones at the bottom of the ocean. 5. They fix themselves by a root to the ground, or to full grown lilies, and when they are old enough break themselves off. 6. The rest of their lives they spend swimming or creeping about. 7. The Sea-Cucumber has neither plates of lime nor spines to protect it, but a very tough skin. 8. The Sea-Cucumber comes into the world as a round soft body, and swims about by swelling out and drawing in its

skin. 9. As it grows older it gets lazy, and only moves in search of food. 10. A Sea-Cucumber can throw away nearly the whole of its body without dying, and grow new organs afterwards.

LESSON XI.

SOME LOWLY CREATURES WITH LIMBS.

Next in order above the Echinodermata comes the great Worm Family, but I pass it over now, as most of its members will be noticed in my little book called "Simple Air-breathers." Above the Worms comes the last great division of animals without backbones whose homes are in the water. The name of this family is CRUSTACEA, a word which means hard-crust; and it is given to the crabs, lobsters, prawns, shrimps, barnacles, water-fleas, and other creatures belonging to the group, because of the hard covering with which their soft bodies are protected.

All Crustaceans have their bodies divided into what are called limbs, or organs of touch and motion quite distinct from each other; a peculiarity which places them near to the higher animals, and far above any of those lower in the scale than themselves. You know of course that your arms and legs are your limbs, and I hope you have noticed that I have never used the word yet, in speaking of the different parts of any of the animals I have described to you in the first

ten lessons of this book. That is because the organs which I have called feet or arms are not limbs or separate organs, but parts of the general body of the creature using them.

The other chief peculiarities shared by all the Crustacea are these. They all have bodies made up of rings, generally as many as twenty-one; their hard crust or armour is divided into the same number of rings; the first seven of these rings with their armour make the head; the next seven the throat; and the rest the abdomen or lower part of the body, containing the stomach and the intestines. The thick crust or armour of the Crustaceans is made of a substance resembling the shells of the Mollusca, and the bones of higher animals; so that this crust forms a kind of link, connecting them both with those below and those above them in the scale of animal life.

Besides these common peculiarities of their structure, or the way their organs are put together, all the Crustaceans share the strange habit of casting off their shells at different times in their lives. The shell when thrown off is an exact picture of the creature which made and lived in it, and I have often picked one up, taking it for a living animal, to find it quite empty and hollow. When a lobster, crab, or any other Crustacean is going to cast its shell, it seems to suffer from a kind of sickness; its limbs grow soft and flabby, and it is not until the new shell has grown hard and firm that it recovers its spirits. Sometimes it loses one of its limbs in

this change, but if it does it soon grows a new one; and if it is injured at any other time below the second joint from the abdomen, it will cast the limb off at that joint. An injury above the joint cannot be remedied in this manner, for it would affect the vital organs, or those with which digestion and breathing are performed.

Most of the Crustacea move in the water with the help of a kind of fan-like tail, growing from the abdomen. They bend this fan suddenly under their throats, let it spring back, and dart tail first through the water. I give you a picture of the fan-like tail of a strange Crustacean called Mysis, which has organs of hearing at the end of each division of its tail. Fancy hearing with a tail!

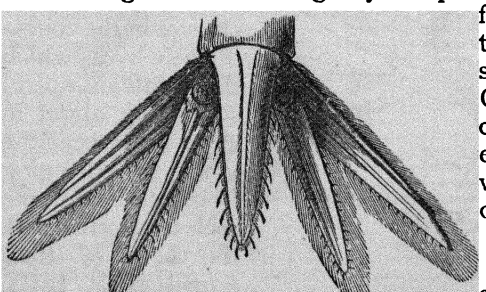


Fig. 23.—TAIL OF MYSIS *(magnified.)*

All the Crustacea use their limbs for walking at the bottom of the water, or on dry ground; and some of them have what are called false legs fastened to the abdomen, with which they scud along at a great pace.

I think you must all have seen a full grown lobster in a fish-shop, even if you have never been

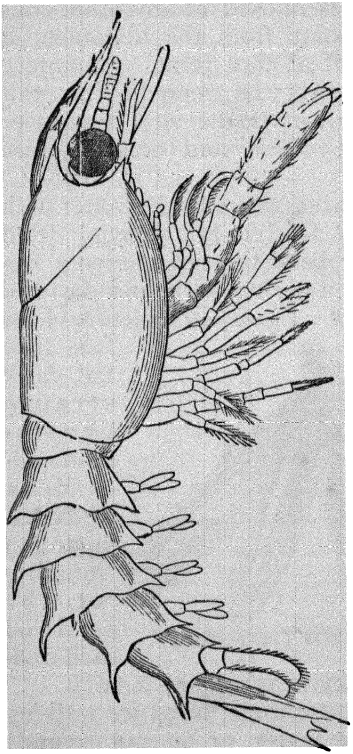


Fig. 24.—YOUNG LOBSTER *(magnified.)*

to the sea-side; so instead of a portrait of one I will give you a picture of a baby lobster, magnified from its real size of a quarter of an inch (——), for you to see its limbs distinctly. This picture will help you to understand how much lobsters change in the course of their lives, which they generally spend swimming about in clear water near the land, or springing from one hole in the rock to another with the help of their wonderful tails. When a lobster is attacked, it defends itself bravely with its claws; and it is no joke to be caught in the strong pincers of one of them.

To-morrow you shall see pictures of other Crustaceans. It is time now to count up the steps we have gained to-day. 1. Next in order

above the Echinodermata are the Worms, most of which live on land. 2. Above the Worms come the Crustacea. 3. Crustacea means hard crust, and the name is given to crabs, lobsters, &c., because of the hard covering with which their soft bodies are protected. 4. All Crustaceans have bodies divided into limbs. 5. Limbs are organs of touch and motion quite distinct from each other. 6. The possession of such separate organs places Crustaceans far above all creatures beneath them in the scale of animal life, and near to the higher animals. 7. The bodies of all Crustaceans are made up of rings with corresponding divisions in the crusty skin containing them. 8. These rings are generally twenty-one in number, seven making the head, seven the throat, and the rest the abdomen or lower part of the body, containing the stomach and intestines. 9. The thick skin of the Crustaceans is made up of a substance resembling both the shells of the Mollusca and the bones of the higher animals. 10. This double likeness is a second link between this family and the families above it. 11. All Crustaceans cast their skins several times in their lives. 12. When about to cast their skins, they seem to suffer from a kind of illness. 13. If a lobster or crab loses a limb in the casting of its shell, it replaces that limb by another. 14. Most Crustaceans move in the water with the help of a fan-like tail, which they bend under their bodies, letting it fly back suddenly. 15. The Mysis, a small Crustacean, is supposed to have hearing organs in its tail. 16.

Some Crustaceans have what are called false legs, fastened to the abdomen.

LESSON XII.

CRABS, BARNACLES, WATER-FLEAS, AND SOME NEST-BUILDING CRUSTACEANS.

Next in importance in the great Crustacean family to the Lobsters are the Crabs, of which there are a very great number of various sizes, from those which can hardly be seen with the naked eye to creatures as large as a soup-plate. All the crabs have very highly organized nervous

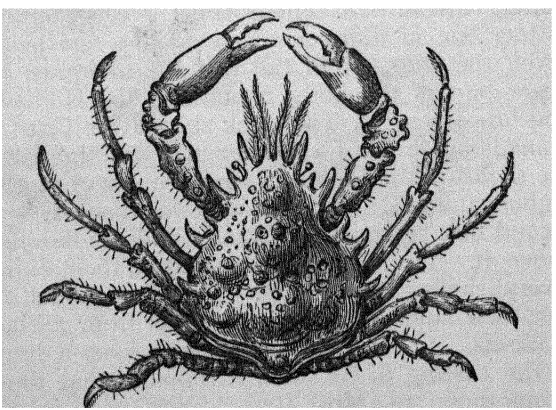


Fig. 25.—CRAB (*life size*).

systems, five pairs of strong limbs, eyes of the kind called compound, and very well developed breathing organs, which are a little different in

those which live on land from those used by water-crabs. I hope you understand that long sentence. To make quite sure that you do I will remind you that a nervous system is a collection of nerves, or organs of feeling, running all over the body in the higher animals, and only over part of the body in the higher of the lower animals. To have a highly organized nervous system, then, must mean to be able to feel easily, and in every limb. I need not again explain what it is to have limbs, need I? I must tell you, though, what a compound eye is, for I have never before had to speak of such an organ. Compound means made up of several parts, so that a compound eye is one made up of several parts. The eye of the crab is divided into six parts, and is set on a little stalk, so that the crab can see all round without turning its head.

I give you here a picture of a full grown crab which is generally found in the water, but which can live and breathe on land. You can clearly see its eyes on their little stalks, though you cannot without a microscope see that those eyes are compound. Crabs, like the rest of the Crustaceans, look very different in babyhood from what they do when full grown. A baby crab looks like a tiny peaked cap, with a fringe round the front and a long pig-tail at the back.

The habits of crabs are very interesting, and they show great intelligence or skill in their manner of life. Some of them live with coral builders as uninvited guests, digging homes for themselves in the coral made by the polypes for

their own protection; others live in shells left empty by their first owners; and others bury themselves in the sand, and dart out suddenly to catch their prey. Crabs are easily caught amongst the rocks, and I advise any of you who can, to get one, and watch his ways for yourselves. Be careful to give him plenty of salt water to swim in, and put some seaweed, shells, and stones at the bottom.

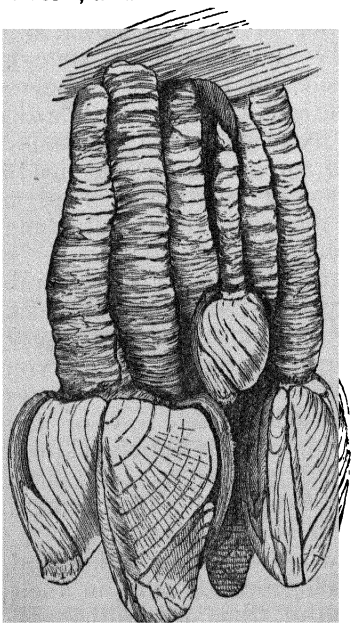


Fig. 26.—GROUP OF BARNACLES (*life size*).

Very different from their cousins the lobsters or the crabs are the lazy Barnacles, which spend their lives fastened to rocks or ships by their long foot or stalk, and catch their food in a kind of net which they send out from their shells.

This picture of a cluster of Barnacles will give you a better idea than a description can of these very strange-looking Crustaceans. The animals themselves live in the shells at the end of the long stalks. They keep these shells closed

when they have had all the food they need, but when they are hungry they open them and send out their nets, which are really a collection of feathery arms. In these beautiful but treacherous organs the barnacles catch small crabs and other water creatures, for which there is no escape when they are once in the meshes of their enemies.

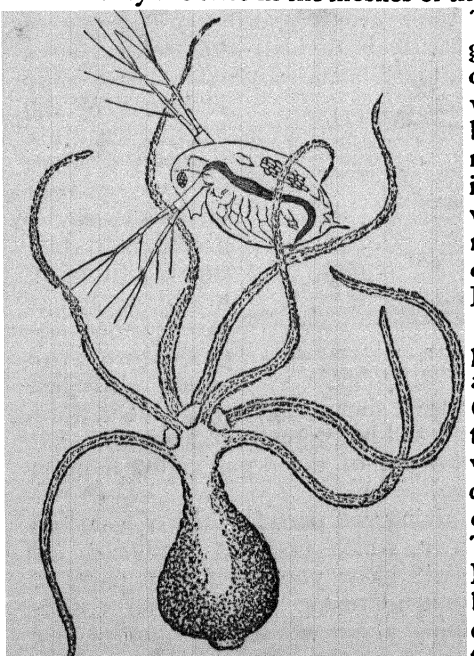


Fig. 27.—HYDRA ATTACKING WATER-FLEA, (*very greatly magnified*).

There are a great many different varieties of barnacles; my picture is of a kind very common on the coasts of England.

Here is a portrait of another Crustacean, taken under very painful circumstances for it. The Water-Flea caught by the hydra belongs to the same family as the lobster,

crab, and barnacle, and as a matter of course it has all the peculiarities of which I told you in Lesson XI. It lives at the bottom of ponds or ditches, and comes up to the surface in the evenings. It is so small that it can only just be seen with the naked eye, but there are such numbers in all ponds that they give quite a reddish colour to the surface when they are taking their evening airing. The eye of this tiny creature is divided into twenty parts, and it has a most beautifully made heart, more like that of the higher animals than any creature we have yet read of together. I give you a picture of this heart, made a great many times larger than the whole water-flea really is, because it shews you how the blood flows in and out, and will help you to understand what is the actual work of the organ called a heart in all animals.

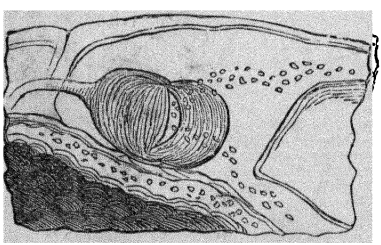


Fig. 28.—HEART OF WATER-FLEA *(very greatly magnified).*

Instead of giving you portraits now of a shrimp and of a prawn, which you can easily see for yourselves, I will shew you the family party of a less well-known Crustacean: a mother Gammarus swimming about with a number of her little ones, fresh from the eggs which she carried for a long time packed under her body to keep

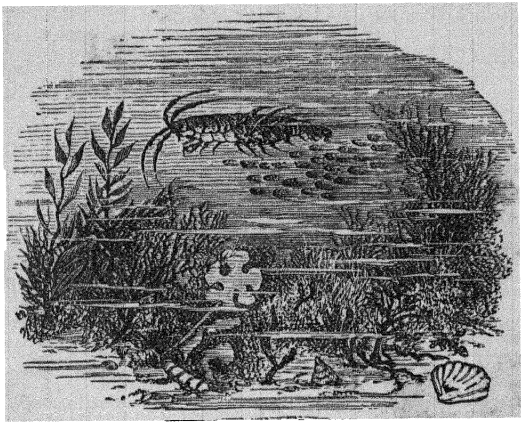


Fig. 29—GRAMMARUS WITH HER YOUNG (*life size*).

them warm. The grammarus, the prawns, and shrimps all hear very quickly. Their organs of hearing are supposed to be behind the smaller of the two pairs of autennæ, as the jointed thread-like organs springing from their heads are called. There is much, you see, still uncertain about many of the Crustaceans; you may be discoverers yourselves of new facts about them some day.

My little picture shews you the shells of several members of the other families you have read about; will you try and find out where each one belongs?

There is one group of Crustaceans, a little like the prawns you see in shops, which builds nests in the water for its young, and keeps them in these nurseries till they are old enough to take

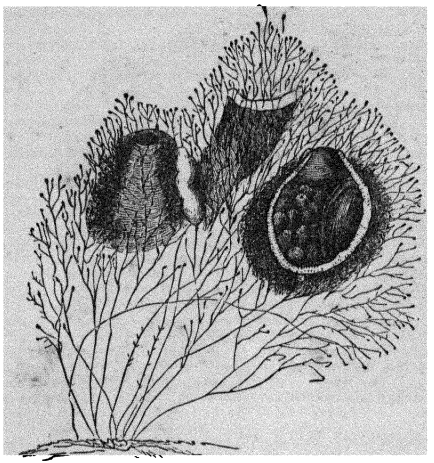


Fig. 30.—NEST OF PODOCERUS CAPILLATUS. *(natural size.)*

care of themselves. Here is a picture of three of these nests, one of them cut in half for you to see the inside. These nests are made of bits of seaweed, joined together with threads spun from the body of the builder; but how, or from what part of that body, no one has yet discovered. Perhaps one of you may find out this; if you do I hope you will write and tell me all about it. The publisher of this book will send your letter to me, wherever I may be. The name given to the Crustaceans which built these nests is PODOCERUS CAPILLATUS,—rather a hard one, is it not? But not nearly so hard as some we have learnt together.

We have now climbed from the very bottom of the Ladder of Animal Life, to the last group of water creatures without backbones; in other words, from invisible animals with no special organs to do the work of living, to animals with

limbs, nerves, hearts, gills, eyes, ears, and the power of making homes for themselves and their children. Above them come the spiders and the insects, about which I will tell you in my little book on "Simple Air-Breathers." Do not forget that I have only told you of very few members of each great family, and that what you have read here is only meant to help you to study nature and her children for yourselves.

To-day we have learnt: 1. Crabs vary in size, from tiny, almost invisible creatures, to forms as large as soup-plates. 2. Crabs have nervous systems of high organization, five pairs of strong limbs, compound eyes, and well-developed breathing organs. 3. A compound eye is one made up of several parts. 4. The eyes of crabs are set on little stalks, so that their owners can see all round without turning their heads. 5. Crabs look very different in their babyhood from what they do when full grown. 6. Some crabs live in coral, boring holes for themselves in it, others in shells left empty by their first owners; others burrow in the sand. 7. Crabs are very active in their habits. 8. Barnacles spend their lives fastened to ships or rocks by a long stalk or foot. 9. They catch their food in a kind of net, which they send out from their shells. 10. This net is a collection of feathery arms, kept folded up in the shells when not in use. 11. The Water-Flea is a very tiny Crustacean of high organization, with eyes divided into twenty parts, and a heart with two chambers or vessels. 12. It lives at the bottom of ponds and ditches, coming up in the evening.

13. The Grammarus is a Crustacean rather like a prawn, which takes great care of its children. 14. Prawns, Shrimps, and other similar Crustaceans, all hear very quickly. 15. Their ears are supposed to be behind the smaller of the two pairs of autennae, or jointed organs of touch growing from their heads. 16. A small Crustacean, called the Podocerus Capillatus, builds nests in the water for its young.

QUESTIONS FOR EXAMINATION ON "LOWLY MANTLE AND ARMOUR-WEARERS."

What is instinct? How can the position of an animal in the scale of organic life be most easily determined? What is the family name of the Lowly Mantle-Wearers? What does this name mean? What is the mantle of these creatures? How are the bodies of the Mantle-Wearers protected? What is the name of the lowest division of the family? What does this name mean? Give an example of this group. Name the chief organs of all members of this group. Have the creatures belonging to this group a heart? If so, of what form is it? How do they breathe? What is the second group of the Mantle-wearing family called? What does this name mean? Give some examples of creatures belonging to this group. Mention in what they resemble and in what they differ from the group beneath them. Of what shape are the shells made by this group? Describe the mode of life of any two creatures belonging to it. What is a muscle? What is a gill? What is the third group in the Mantle-wearing family? What does its name mean? What kind of shells do the members of this group make? Describe the appearance, organs, and mode of life of some one member of this group. Give the name of the fourth group of Mantle-Wearers. What does this name mean? What is the chief difference between this group and all other Mollusca?

Describe the appearance and mode of life of some one member of this group. What water-creatures closely resemble the fourth group of Mantle-Wearers? What wonderful peculiarity has the Lymnæa, distinguishing it from all other Mantle-Wearers? What is the fifth group of the Mollusca family? What does its name mean? Give an example from this group, and describe its appearance and mode of life. What is the sixth and last group of Mollusca called? What does this name mean? Describe the Octopus, give the meaning of its name, and mention some of its habits. Describe the Cuttle-fish, and explain in what it differs from the Octopus. Describe the Calmar. Have the Octopus, Cuttle-Fish, and Calmar shells? Describe the Argonaut, and mention some of its habits. How do all the Mollusca come into the world? What family is next above the Mollusca? What does its name mean? Give examples of this family. Name the peculiarities shared by all its members. What chiefly distinguishes them from the Mollusca? Describe the Star-Fish. How does it walk? Can it see? Describe the Echinus How does it walk? Describe the Brittle-Star, Sea-Lily, and Sea-Cucumber. Give one or two instances of their habits. What family succeeds the Echinodermata? What is the chief thing which places this family higher than the one beneath it? What is a limb? Where are the organs of hearing of the Mysis? Describe a young lobster. Describe a crab. Describe a group of barnacles. How do barnacles catch their food? Describe the heart of a water-flea. Name a Crustacean which cares for its young. Name a nest-building Crustacean.

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